Can 12 Men Run a Submarine?

page 28

electronics

A McGRAW-HILL PUBLICATION JANUARY 29, 1960 PRICE SEVENTY-FIVE CENTS

Cryotron Shift Register

page 55

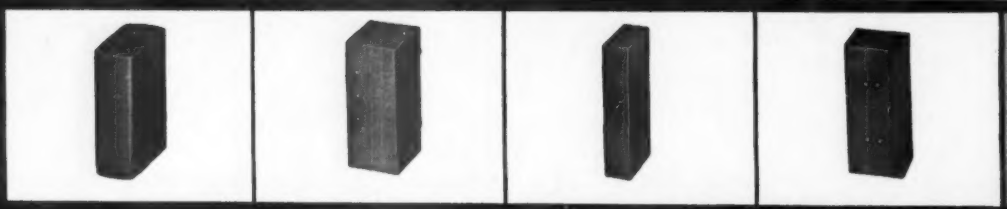
UNIVERSITY MICROFILMS IN
EDITORIAL DEPT
313 N FIRST ST
ANN ARBOR MICH

For Your Special Applications

The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

FILTERS

All types for frequencies from .1 cycle to 400 MC.



400 ~ telemetering, 3 db at ± 7.5%, 40 db at 230 and 700 ~, ⅝ x 1¼ x 2".

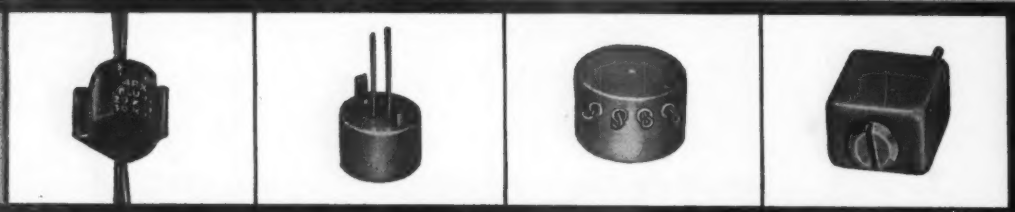
15 ~ BP filter, 20 db at 30 ~, 45 db at 100 ~, phase angle at CF less than 3° from —40 to + 100° C.

LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85° C., 45 db at 55 KC.

LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.

HIGH Q COILS

Toroid, laminated, and cup structures from .1 cycle to 400 MC.



Tuned DO-T servo amplifier transformer, 400 ~ .5% distortion.

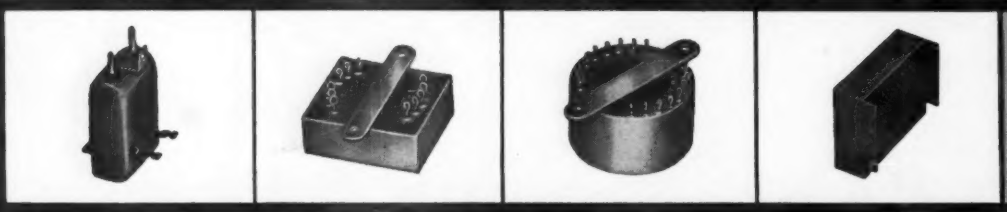
Toroid for printed circuit, Q of 90 at 15 KC.

Dual toroid, Q of 75 at 10 KC, and Q of 120 at 5 KC.

HVC tapped variable inductor for 3 KC oscillator.

SPECIALTIES

Saturable reactors, reference transformers, magnetic amplifiers, combined units.



RF saturable inductor for sweep from 17 MC to 21 MC.

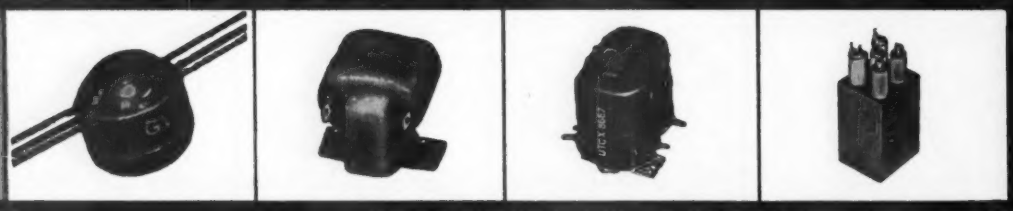
Voltage reference transformer .05% accuracy.

Multi-control magnetic amplifier for airborne servo.

Input, output, two tuned interstages, peaking network, and BP filter, all in one case.

PULSE TRANSFORMERS

From miniature blocking oscillator to 10 megawatt.



Wound core unit .01 microsecond rise time.

Pulse current tansformer 100 Amp.

Pulse output to magnatron, diffiar filament.

Precise wave shape pulse output, 2500 V. 3 Amps.

POWER COMPONENTS

Standard and high temperature . . . hermetic, molded, and encapsulated.

Multi-winding 140 VA, 6 KC power transformer 1¼ x 1¼ x 1"

200° C. power transformer, 400 ~, 150 VA.

400 ~ scope transformer, 20 KV output.

60 ~ current limiting filament transformer, Sec. 25 Mmfd., 30 KV hipot.

UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y. • EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y.,
CABLES: "ARLAB" PACIFIC MFG. DIVISION, 4008 W. Jefferson Blvd., Los Angeles, Cal.

electronics

JANUARY 29, 1960

A McGRAW-HILL PUBLICATION
Vol. 33 No. 5

JAMES GIRDWOOD, *Publisher*

W. W. MacDONALD, *Editor*

JOHN M. CARROLL, *Managing Editor*
Senior Associate Editors: Samuel Weber, Roland J. Charest
Associate Editors: Frank Leary, Michael F. Tomaino, Howard K. Janis, Sylvester P. Carter, William P. O'Brien, John F. Mason, William E. Bushor, Thomas Emma, Sy Vogel, Leslie Solomon, M. M. Perugini, George J. Flynn
Assistant Editors: Michael F. Wolff, Nilo Lindgren, Harold M. McKean
Regional Editors: Harold C. Hood (Pacific Coast, Los Angeles), Harold Harris (Midwestern, Chicago), Thomas Maguire (New England, Boston)
Market Research Editor: Edward DeJongh
Buyers' Guide Editor: George Sideris
Art Director: Harry Phillips
Production Editor: John C. Wright, Jr.
Editorial Assistants: Gloria J. Filippone, Arlene Schilp, Bernice Duffy, Patricia Landers, Carol Weaver, Marian L. Freed, Dolores A. Fornaro, Lorraine Rossi, Dorothy Smith, Virginia T. Bastian

BRUCE A. WINNER, *Advertising Sales Manager.* R. S. Quint, *Assistant Advertising Sales Manager and Buyers' Guide Manager.* Fred Stewart, *Promotion Manager.* Richard J. Tomlinson, *Production Manager.* George E. Pomeroy, *Classified Manager.* Hugh J. Quinn, *Circulation Manager*

Advertising Representatives: New York: Donald H. Miller, Henry M. Shaw, George F. Werner. Boston: Wm. S. Hodgkinson. Pittsburgh: David M. Watson. Philadelphia: Warren H. Gardner, William J. Boyle. Chicago: Harvey W. Wernecke, Martin J. Gallay, Cleveland: P. T. Fegley. San Francisco: T. H. Carmody, R. C. Alcorn. Los Angeles: Carl W. Dysinger, D. A. McMillan, Marshall Freeman. Denver: J. Patten. Atlanta: M. Miller. Dallas: Gordon L. Jones, Robert T. Wood. London: Norman Strick. Frankfurt: Stanley Kimes. Geneva: Michael R. Zeynel

Issue at a Glance

Business

Navy Plans 12-Man Killer Sub. Automation goes underseas..... 28

New Budget: Electronics Holds the Line. A look at fiscal '61..... 32

New Approaches to Reliability. Fewer unit cost compromises?..... 39

R&D to Surpass $15 Billion. Federal spending to set record..... 40

Shoptalk 4
Business This Week.....11
Washington Outlook 14
Financial Roundup.....21
25 Most Active Stocks.....21
Market Research 24
Current Figures.....24
Meetings Ahead.....48

Engineering

Experimental cryotron shift register described by GE engineers has insulator film separating grids from gate film. See p 55..COVER

Computers Head for 1,000-Mc Operation. Improved memory and logic units aid computer evolution.....By T. Maguire 55

Solid-State Guidance for Able-Series Rockets. Transistorized circuits control pitch, yaw and roll.....By R. E. King and H. Low 60

In Fog and Rain—Sight, IR or Radar? Effective range of three detecting methods.....By M. E. Seymour 64

Detecting Signals by Polarity Coincidence. Instrument uses digital techniques to detect signals in noise.....By B. M. Rosenheck 67

Transistorized Slicer Analyzes Signal Amplitude. Simple circuit determines amplitude probability density functions..By T. A. Bickart 70

Departments

Research and Development. Spectrometer for Basic Research..... 74

Components and Materials. Cesium Cell for Power Conversion..... 78

Production Techniques. Develop Strippable P-C Negatives..... 82

On the Market.....86
Literature of the Week.....94
Plants and People.....96
News of Reps..... 98
Comment 100
Index to Advertisers.....106

National 2N1440 SERIES and 2N327A SERIES

IMMEDIATELY AVAILABLE FROM STOCK

OUTSTANDING PRODUCT FEATURES

highest device dissipation
400 mw at 25°C
170 mw at 125°C

highest junction temperature
200°C

guaranteed β at 150°C
(2N1440 series, only)

guaranteed high temperature I_{CBO}
(2N1440 series at 150°C)
(2N327A series at 125°C)

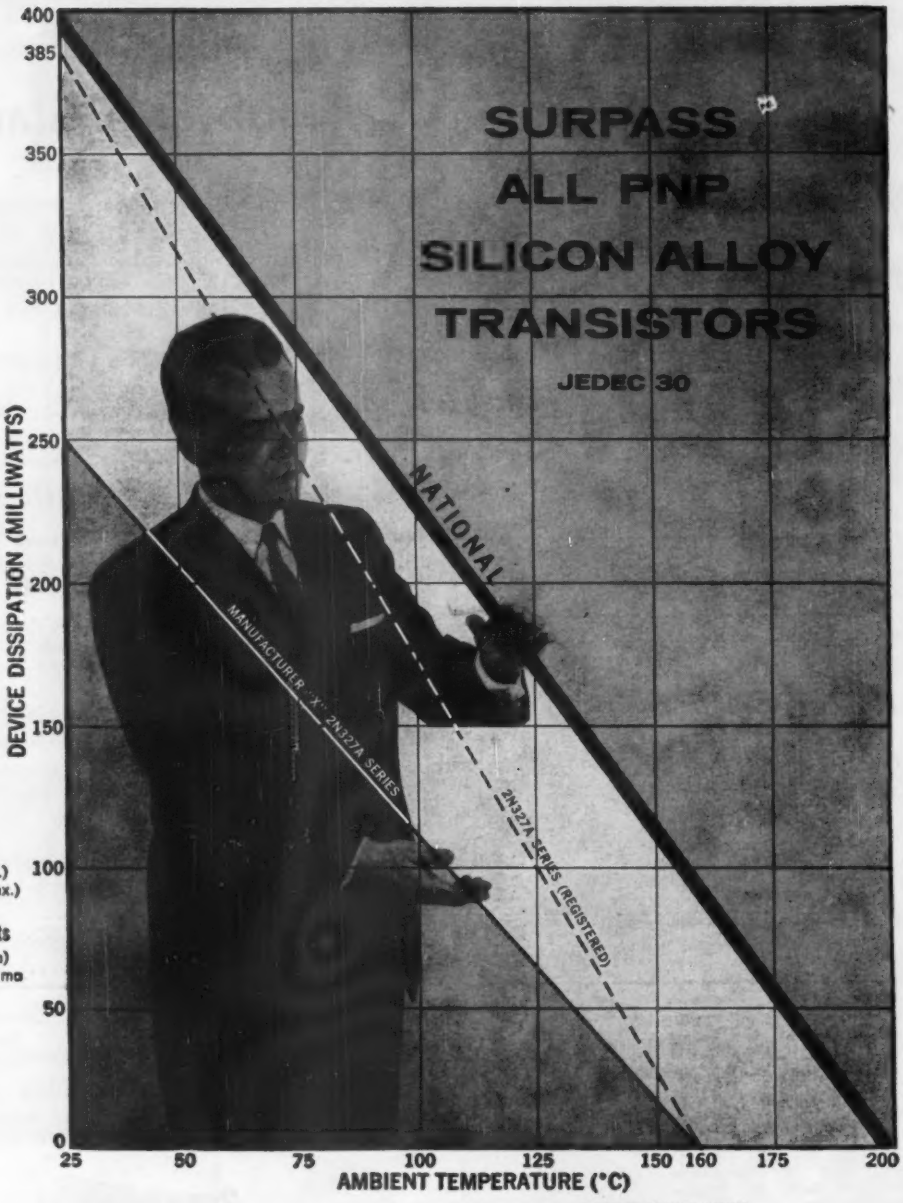
contamination-free...
no desiccants used

extremely low leakage
(2N1440 series, 25mμa max.)
(2N327A series, 100mμa max.)

guaranteed β at low currents
(2N1440 series, at I_C = 1 ma)
(2N327A series, at I_B = 0.1 ma and I_B = 1.0 ma)

low saturation resistance

shock and vibration...
exceed MIL-S-19500B



For Product Specifications, Delivery and Prices—Write, Wire or Phone:

National SEMICONDUCTOR CORPORATION

P.O. Box 443, Danbury, Conn. • Pioneer 3-7624 • TWX DANB 452-U

WESTERN REGION OFFICE
National Semiconductor Corp.
690 N. Sepulveda Blvd., El Segundo, California.
ORegon 8-4161 TWX EL SEG 4092-U

BALTO.-WASHINGTON AREA
C. H. Newson and Associates
17 Croftley Road, Lutherville, Maryland • VAlley 3-0433

CAMDEN-PHILADELPHIA AREA
C. H. Newson and Associates
813 Bethlehem Pike, Philadelphia 18, Pa. • CHestnut Hill 8-3377

MINNEAPOLIS AREA
Lloyd F. Murphy & Assoc., Inc.
1700 Hennepin Ave., Minneapolis 3, Minn. • FEderal 9-4853

DISTRIBUTOR
Milgray Electronics Inc.
136 Liberty Street, New York, New York • REctor 2-4400

Good anywhere in or out of this world

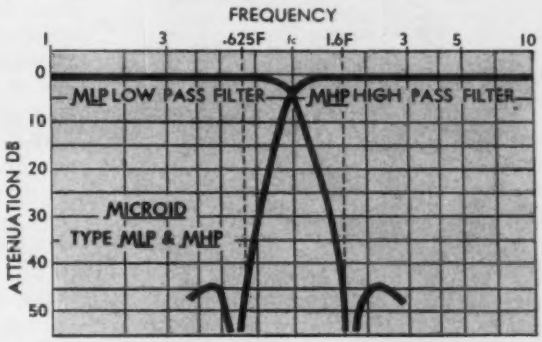
This system adds greatly to your credit when applied to the development of communications, telemetering, control and other devices. Under terms of membership, a wide range of toroids, filters and related networks are available. These include a complete line of inductors, low pass, high pass and band pass filters employing the new micro-miniature *MICROID* ® coils so valuable in transistorized circuitry. Type *MLP* and *MHP MICROIDS* are micro-miniature counterparts of the popular Burnell types TCL and TCH low pass and high pass filters. The band pass filter results when cascading a TCL with a TCH filter.

Sizes of MLP and MHP MICROIDS

400 cps to 1.9 kcs — $1\frac{1}{16}$ x $1\frac{15}{16}$ x $\frac{1}{2}$
2 kcs to 4.9 kcs — $1\frac{1}{16}$ x $1\frac{5}{8}$ x $\frac{1}{2}$
5 kcs and up — $\frac{5}{8}$ x $1\frac{5}{16}$ x $\frac{1}{2}$

Weight of all MLP and MHP Microids—approx. .3 ozs. each

Send now for your free membership card in the Space Shrinkers Club. And if you don't already have our Catalogue #104 describing Burnell's full line of toroids, filters, and related networks, please ask for it.



Note: First informal meeting of Club members will be held in Burnell Booths 2919-2921 during the IRE Show, New York Coliseum, March 21-24. See you there.

Burnell & Co., Inc.
PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION
DEPT. E-29
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000
TELETYPE PELHAM 2633

PACIFIC DIVISION
DEPT. E-29
720 MISSION ST.
SOUTH PASADENA, CAL.
MURRAY 2-2841
TELETYPE PASACAL 7378

CIRCLE 3 ON READER SERVICE CARD

electronics
January 29, 1960 Vol. 33, No. 5

Published weekly, including the ELECTRONICS BUYERS' GUIDE and REFERENCE Issue in mid-June as part of the subscription, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948) Founder.

Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y. Longacre 4-3000. Publication Office: 99-129 North Broadway, Albany 1, N. Y.

See panel below for directions regarding subscriptions or change of address. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary; Nelson L. Bond, President, Publications Division; Shelton Fisher, Senior Vice President; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

Single copies in the United States, U. S. possessions & Canada 75¢; $1.50 for all other foreign countries. Buyers' Guide in the United States, U. S. possessions & Canada $3.00; all other foreign $10.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years; $12.00 for three years. Canada, $10.00 a year; $16.00 for two years; $20.00 for three years. All other countries, $20.00 a year; $30.00 for two years; $40.00 for three years. Second class postage paid at Albany, N. Y.
Printed in U.S.A. Copyright 1960 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved. Title registered in U. S. Patent Office.
BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11; 68 Post Street, San Francisco 4; McGraw-Hill House, London E. C. 4; 85, Westendstrasse, Frankfurt/Main; National Press Bldg., Washington 4, D. C.; Six Penn Center Plaza, Philadelphia 3; 1111 Henry W. Oliver Bldg., Pittsburgh 22; 55 Public Square, Cleveland 13; 856 Penobscot Bldg., Detroit 26; 3615 Olive St., St. Louis 8; 350 Park Square Bldg., Boston 16; 1301 Rhodes-Haverty Bldg., Atlanta 3; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2; 901 Vaughn Bldg., Dallas 1. ELECTRONICS is indexed regularly in The Engineering Index.

Subscription: Address correspondence to: Fulfillment Manager, Electronics, 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address, stating old as well as new address, including postal zone if any. Subscriptions are solicited only from persons engaged in theory, research, design, production, management, maintenance and use of electronics and industrial control components, parts and products. POSITION and COMPANY CONNECTION must be indicated on subscription orders.

Postmaster: please send form 3579 to Electronics, 330 W. 42nd St., New York 36, N. Y.

Member ABP and ABC

SHOPTALK . . . editorial

INTERNATIONAL SYMBOLOGY. This spring a U.S. engineer will travel to Paris to represent our National Committee at an International Electrotechnical Commission meeting on letter symbols for electronics.

There is nothing unusual about U.S. engineers attending international meetings. However, in the past they usually paid their own way—unless going to full-dress plenary meetings or to IEC meetings of high trade interest such as those dealing with standardization of hardware. This time, the delegate is going to a working meeting of a purely professional group and the Institute of Radio Engineers is paying part of his expenses.

This is a badly needed step in the right direction and here is why: the IEC advises the International Science Organization, an arm of the United Nations, on electrical matters. The international standards set by IEC often make up the book of technical rules U.S. firms must play by when doing business abroad. And in the areas of contract proposals, patent proceedings and equipment maintenance international standards for letter symbols, graphical symbols and terminology are as important as standards for equipment and components.

Although U.S. delegates have attended plenary sessions of purely professional IEC groups, they have often been there only to agree to an agenda hammered out in advance by a working or experts' group.

Nevertheless, we wonder whether professional organizations alone should have to help with the expense of sending delegates to meetings where their work will also benefit U.S. industry. Isn't the support of the U.S. National Committee of the International Electrotechnical Commission an obligation that might also be assumed by electronics trade associations whose members stand to benefit from increased export business?

Coming In Our February 5 Issue . . .

NOISE DISPLAY. Computing the ratio of two time-varying quantities is an important step in various data processing operations. Both analog computers with servo control and digital computers have been used for this purpose. However, for special applications it is often more desirable to use an electronic analog computer because of its high speed compared with the servo type and its simplicity compared with the digital type.

In our next issue, J. Tamiya of the University of Minnesota describes an electronic analog computer that automatically computes and displays the noise suppression factor of tube shot noise. This instrument, which is part of a noise display machine being developed by A. van der Ziel, samples plate current and noise output. The amplitude ratio of these sampled values is transformed into a time ratio whose denominator is constant. The time quantity in the numerator becomes the only variable and represents the desired ratio of true to pure shot noise. This ratio is displayed as a vertical deflection on a cathode ray oscilloscope.

CERAMIC ROD ANTENNAS. Ceramic rods used as antenna elements have high power handling ability limited only by the temperature effects of the low-loss material. With high-dielectric materials, the volume of the individual elements is reduced, thereby minimizing weight.

These characteristics make such rods suitable for uhf antenna arrays according to C. W. Morrow and J. L. Moore of Melpar, in Falls Church, Va. They describe a 17-element array of Alite rods and indicate its radiation pattern for X-band frequencies.

HOW TO SELECT HIGH RELIABILITY CAPACITORS

At one time Sprague Electric was the only manufacturer offering true high reliability capacitors. The buyer had no problem. But today there are many manufacturers who claim that their capacitors meet high reliability standards. Some are even so bold as to claim that theirs are *the most reliable.*

Check the record before you choose

The only sound approach to evaluate these claims is to investigate the *reliability record* achieved by each of the companies under consideration. Remember, it takes test data to establish the reliability of a product. Claims are not enough.

Now let's look at the record

Sprague Electric can substantiate its claim that its HYREL® Q Capacitors are "the most reliable capacitors made" with the most extensive test data available in the entire electronic industry. The performance of HYREL Q Capacitors is virtually impossible to surpass . . . now and for some years to come.

But let's start at the beginning—*the specifications.* Sprague Electric's high reliability capacitors were originally made under Sprague Electric Specification PV-100—*the first high reliability capacitor specification for missiles and other critical applications.* This specification and a later revision, PV-100A, have proven so comprehensive and so successful in providing "the highest order of reliability known to capacitor manufacturing" that their provisions are currently reflected in *every* military specification covering high reliability capacitors. This is a distinction shared by no other capacitor manufacturer.

Now look at the record of HYREL Q Capacitors

On accelerated life tests the failure rate of HYREL Q Capacitors has been less than 0.05%, after more than 16 million unit hours accumulated on tests of 250 hours at 140% rated voltage, 125 C. On high frequency vibration tests, there hasn't been a single failure in the more than 50,000 units tested. On seal, moisture resistance, and temperature cycling and immersion tests, the failure rate has been less than 0.1%.

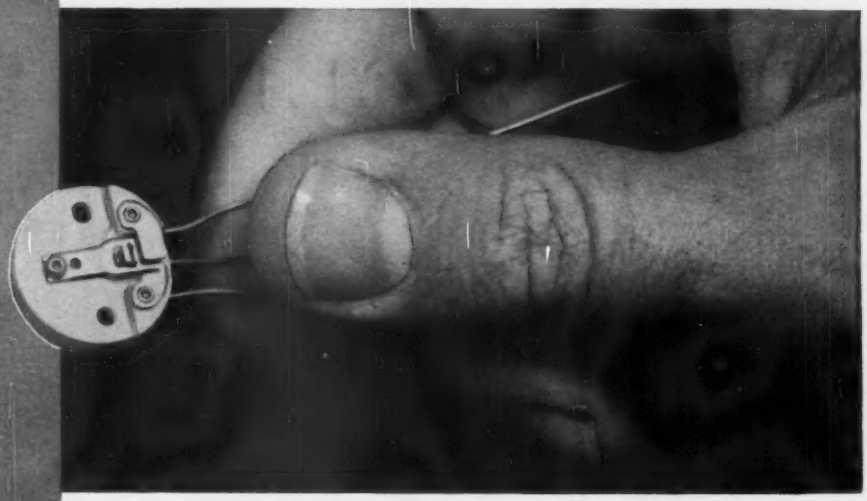
Such performance from production line capacitors can only be achieved through the most intensive (and expensive) kind of reliability program—in design and development, in production engineering, in manufacturing facilities, in testing intensity and extensity—all of which should be investigated thoroughly.

After you've checked the record, then decide for yourself which capacitor is "the most reliable made."

For complete facts and figures on HYREL Q Capacitors, call your Sprague District Office or Representative, or write for HYREL Bulletin 2900A and Specification PV-100A to Technical Literature Section, Sprague Electric Company, 35 Marshall St., North Adams, Massachusetts.

SUPRAMICA® 560 ceramoplastic

the world's most nearly perfect precision-molded electronic insulation



gives this MICRO SWITCH assembly

A DIVISION OF MINNEAPOLIS-HONEYWELL

total dimensional stability!

This subminiature assembly—no bigger than your thumbnail—is a high-temperature switch, precision-made for the MICRO SWITCH Division of Minneapolis-Honeywell, and designed for use in missiles, aircraft and other electronic "hot spots." Precision-molded of SUPRAMICA 560 ceramoplastic, the switch base has *total dimensional* stability at temperatures up to +750°F in this application, and up to +932°F in many others. It has also been used in extreme *low* temperature applications as found in missile launching environments.

Reports MICRO SWITCH: "*Selection was founded on the characteristics of SUPRAMICA'S moldability, and dimensional stability and control. These are of utmost importance in the production and application of the 6SM switch.*"

"*It allows us to mold terminal inserts into the switch base, parallels the expansion characteristics of the stainless steel terminal inserts, and eliminates dimensional variations during a production run. This promotes extended switch life and helps MICRO SWITCH maintain the quality and reliability for which our products are known.*"

SUPRAMICA 560 is one of a unique family of precision-molded and machinable ceramoplastics and glass-bonded mica insulation materials. Whatever insulation characteristics you require, there is a Mycalex Corporation of America material to meet your need—for example, SUPRAMICA 620 machinable ceramoplastic offers a maximum operating temperature of +1550°F. Write today for specific information.

General Offices and Plant: 120-K Clifton Blvd., Clifton, N. J.
Executive Offices: 30 Rockefeller Plaza, New York 20, N. Y.

SYNTHAMICA SUPRAMICA MYCALEX

MYCALEX
CORPORATION OF AMERICA

WORLD'S LARGEST MANUFACTURER OF GLASS-BONDED MICA AND CERAMOPLASTIC PRODUCTS

REGATRAN®
SEMICONDUCTOR
POWER SUPPLIES...

Here's reliability . . . Since their introduction, over 24 months ago, not one Regatran has lost a series transistor due to short circuits or overloading.

- transistorized
- short circuit proof
- super-regulated
- overload protected
- low output impedance
- lowest ripple
- high-speed regulation
- drift balance control
- sensing terminations
- front panel calibration
- any grounding arrangement
- small size, light weight

Regatran Semiconductor Power Supplies are available in various ratings up to 0 to 60 V dc and 0 to 30 amperes, depending on model. Write for Bulletin 721.

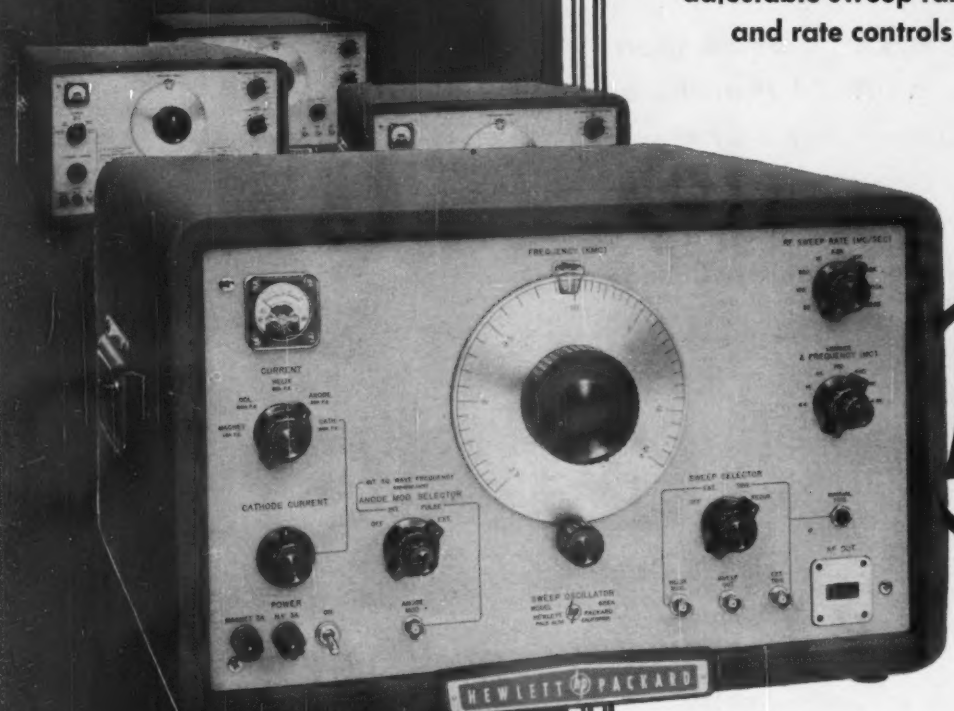
ELECTRONIC MEASUREMENTS
COMPANY OF RED BANK
EATONTOWN · NEW JERSEY

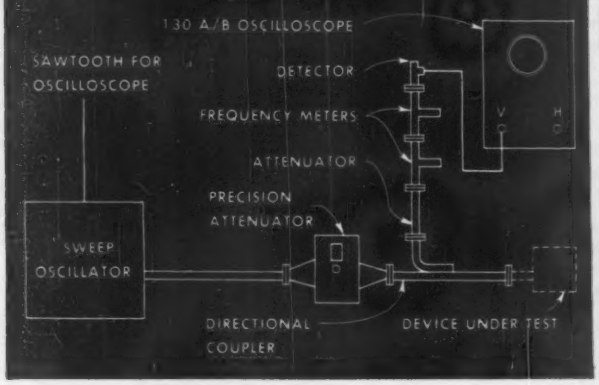
®Regatran is a registered trademark of Electronic Measurements Company of Red Bank. Patents Pending.

4 new microwave sweep oscillators

speed, simplify measurements 2.0 to 18.0 KMC

Covers full band, or any part
Use with 'scope or recorder
All electronic; no mechanical sweep
Direct reading, independently adjustable sweep range and rate controls





◀ Figure 1. Arrangement for high speed microwave measurement to provide rapid visual display with hp 130A/B oscilloscope.

hp Dependable, quality

Hewlett-Packard Electronic Sweep Oscillators are new measuring tools deliberately designed to give you simpler, faster microwave measurements. Four models are provided, covering frequencies 2.0 to 18.0 KMC as follows: Model 683A, 2.0 to 4.0 KMC; Model 684B, 4.0 to 8.1 KMC; Model 686A, 8.2 to 12.4 KMC and Model 687A, 12.4 to 18.0 KMC.

These instruments make possible microwave investigations and evaluations with a convenience previously associated only with lower frequency measurements. These oscillators provide a wide range of sweep speeds so that measurements of reflection, attenuation, gain etc., can be displayed on an oscilloscope or recorded in permanent form on X-Y or strip-chart recorders.

Electronic Sweeping

Specifically, the new oscillators provide either a CW or swept rf output throughout their individual bands. The instruments employ new backward wave oscillator tubes whose frequency is shifted by varying an applied potential. Thus, troublesome mechanical stops and tuning plungers are eliminated. Sweep range is continuously adjustable and independently variable; sweep rate is selected separately, and either can be changed without interrupting operation. The full band width can be covered in time segments ranging from 140 seconds (very slow for mechanical recorder operation) to 0.014 seconds (high speed for clear, non-flickering oscilloscope presentation).

Linear Frequency Change

The swept rf output from the hp sweep oscillator is linear with time, and a linear sawtooth voltage is provided concurrent with each rf sweep to supply a linear time base for an oscilloscope or recorder. In addition, for convenience in recording and other operations, rf sweeps can be triggered electrically externally and single sweeps can be triggered by a front panel push button. The rf output can also be internally AM'd from 400 to 1,200 cps and externally AM'd or FM'd over a wide range of frequencies.

Rapid Visual Presentation

The variety of sweep rates and band widths available from the new oscillators insures convenience and accuracy for reflection and transmission coefficient measurements and many other production line and laboratory tests. For maximum speed, an oscilloscope such as hp 130A/B may be used as indicated in the diagram on opposite page. For maximum information and a permanent record, an X-Y or strip chart recorder may be used.

Complete details of a rapid visual method using an oscilloscope or a maximum-data, permanent record method using a recorder may be obtained from your hp field engineer. Detailed discussions of these methods are also contained in the hp Journal, Vol. 8, No. 6, and Vol. 9, No. 1-2, available on request.

TYPICAL SPECIFICATIONS

Below are specifications for -hp- 686A Sweep Oscillator, 8.2 to 12.4 KMC. Specifications for -hp- 683A, 684B, and 687A (P band) are similar except for frequency range and other minor variations.

Types of Outputs: Swept Frequency, CW, FM, AM.

Single Frequency Operation

Frequency: Continuously adjustable 8.2 to 12.4 KMC.

Power Output: At least 10 milliwatts into matched waveguide load. Continuously adjustable to zero.

Swept Frequency Operation

Sweep: Recurrent; externally triggered; also manually triggered single sweep. Rf sweep linear with time.

Power Output: At least 10 MW into matched waveguide load. Output variation less than 3 db over any 250 MC range; less than 6 db over entire 8.2-12.4 KMC range.

Sweep Range: Adjustable in 7 steps 4.4 MC to 4.4 KMC.

Sweep Rate-of-Change: Decade steps from 32 MC/sec. to 320 KMC/sec.

Sweep Time: Determined by sweep range and rate; from 0.014 to 140 seconds over full-band.

Sweep Output: +20 to +30-volt-peak sawtooth provided at a front-panel connector concurrent with each rf sweep.

Modulation

Internal Amplitude: Square wave modulation continuously adjustable from 400 to 1200 cps; peak rf output power equals cw level ± 1 db.

External Amplitude: Direct coupled to 300 KC; 20 volt swing reduces rf output level from rated cw output to zero.

External Pulse: +10 volts or more, 5 microsecond maximum duration.

External FM: Approx. 350 v peak to modulate full frequency range.

General

Input Connectors, Impedances: BNC; above 100,000 ohms.

Output Connector: Waveguide cover flange (686A, 687A); Type N, female (683A, 684B).

Power Requirements: 115/230 volts ±10%, 50/60 cps; approximately 340 watts.

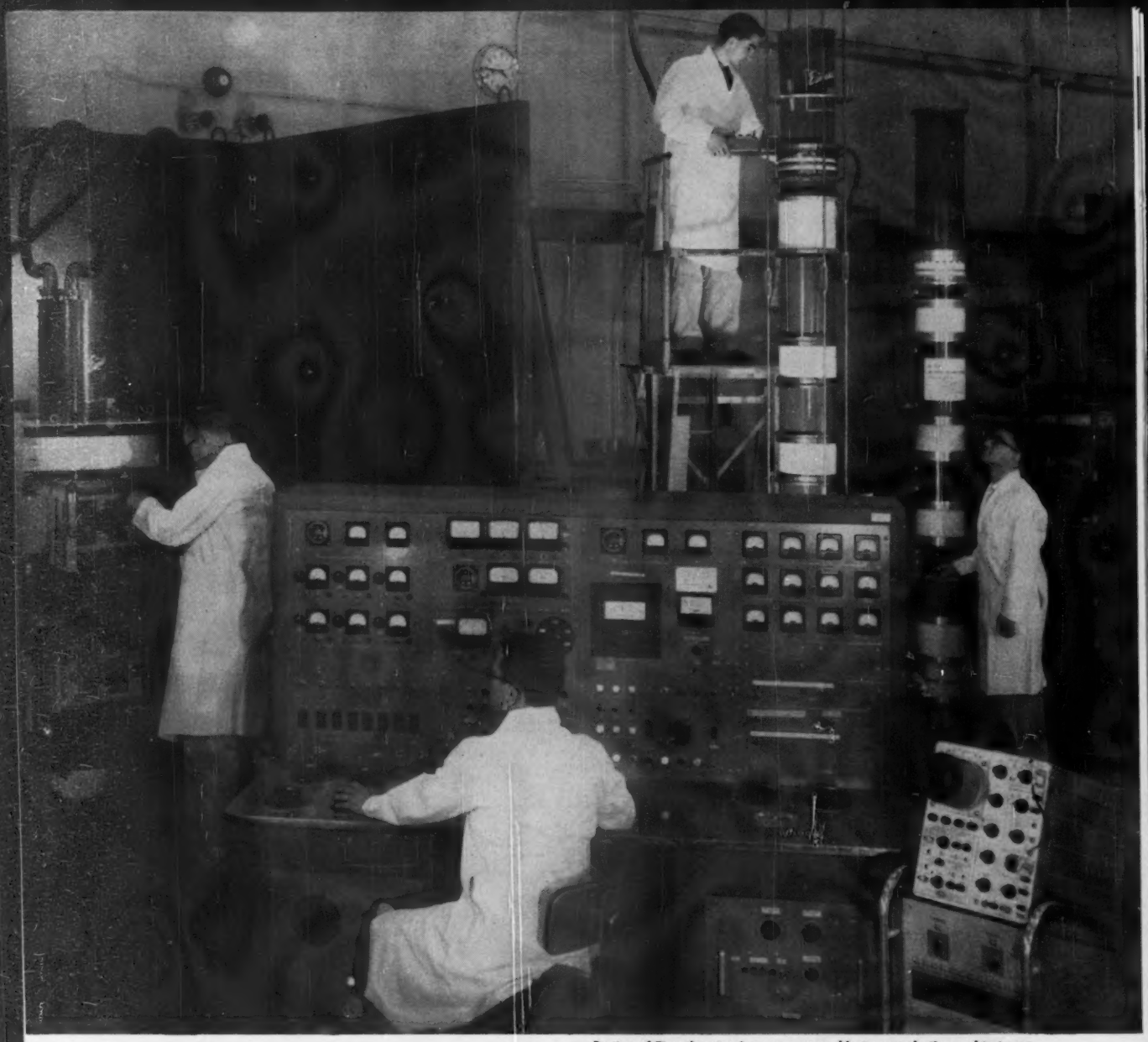
Price: hp 683A (2.0 to 4.0 KMC) $3,000.00.
hp 684B (4.0 to 8.1 KMC) $2,900.00.
hp 686A (8.20 to 12.40 KMC) $2,900.00.
hp 687A (12.40 to 18.00 KMC) $3,400.00.

(Prices above are f.o.b. factory for cabinet models. Rack mount instruments $15.00 less.)

Data subject to change without notice.

HEWLETT-PACKARD COMPANY
4478A Page Mill Rd. • Palo Alto, California, U.S.A.
Field Representatives in All Principal Areas
Cable "HEWPACK" DAvenport 5-4451
4478-R

instruments that speed and simplify your work



Portion of Eimac's extensive super-power klystron production and test area

MORE EIMAC KLYSTRONS PRODUCED FOR UHF SUPER-POWER RADAR THAN ALL OTHER TUBES COMBINED

A decade ago Eimac decided that negative-grid tubes were impractical to generate high power at UHF. Instead, Eimac developed external cavity klystrons and opened the upper spectrum to high power propagation. With high power at UHF new applications and systems have been made possible.

Custom, laboratory-made tubes can't begin to meet the demands of systems such as UHF space radar. In keeping with its pioneering tradition, Eimac was a leader in developing super-power, long-pulse klystrons for this system—and followed through with quantity production.

This combination of development and production has placed Eimac klystrons in more tropospheric communications and UHF super-power radar transmitters than all other makes of final amplifier tubes combined. And Eimac will continue to convert its developments to production to meet the increasing demand.

For high power at ultra-high frequencies, investigate the many advantages of Eimac external cavity amplifier klystrons.

EITEL-McCULLOUGH, INC.

San Carlos • California

BUSINESS THIS WEEK

Superconductive Gyro Called Feasible; Use Seen in Subs and Space Vehicles

Superconductive gyro under development at GE's new $100,000 low temperature facility in Schenectady, N. Y. is expected to give significantly higher accuracy and reliability than conventional gyros. The gyro, which operates at about −452 F., is expected to find applications first in nuclear submarines and later in space vehicles. A cooling system would be required. Although a laboratory working model may not be ready until the end of the year, GE cryogenicists have demonstrated its feasibility. Gyro rotor is freely suspended in a magnetic field, operates at liquid helium temperatures.

Work, dubbed Project Spin, is being done under a $214,000 first-phase contract from the Army.

New Magnet Memory Units To Be Produced by Bell System

Twistor permanent magnet memory conceived at Bell Telephone Laboratories only 14 months ago is reported now ready for mass production by Western Electric. The two Bell System companies, in an unusual joint announcement, say computer technology will be advanced by the memory unit which they report is comparatively inexpensive and easy to produce, yet capable of supplying bits of information in millionths of a second.

Unit consists of alternating grids of "twistors"—hair-thin copper wires around each of which is wrapped a magnetic tape 1/10 the thickness of the wire—and plastic cards with arrays of minute bar magnets. The "Magnet-Twistor memory" stores data by the presence or absence of a bar magnet at a specific location on the plastic card.

Multivibrator 'Grown' from Pool Of Molten Semiconductor Materials

Scientists of Westinghouse Electric reported last week they are able to "grow" a multivibrator directly from a pool of molten semiconductor materials. This development, made possible by the dendrite process of growing crystals, is the latest application of the firm's molecular electronics concept.

Both Westinghouse and the Air Force claim this approach makes possible subsystems 1/1,000 the size of those presently used. Westinghouse says it has developed and demonstrated eight classes of function blocks including: an audio amplifier, two-stage video amplifier, a variable potentiometer, an analog-to-digital converter, and a variety of multivibrators. Col. W. S. Heavner, Chief of the Wright Air Development division's Electronic Technology Laboratory, looks for a complete system—a molecularized vhf receiver—to be produced during 1962.

Electroluminescent Device Output Will Increase for Several Markets

Plans to expand production of electroluminescent devices have been announced by Sylvania Electric, for a wide variety of military and civilian applications. These will include computers, radar and general information displays for the military, and clock faces, switch plates, instrument faces in commercial application. A large volume of sales will go to automative manufacturers, some of whom are already including electroluminescent lighting in car dashboards. Company officials say the most valuable feature of the new devices is that they can be made to perform the logic and memory functions required in computer applications as well as to display information.

ELECTRONICS NEWSLETTER

Microelectronics will come in for some special attention at the 1960 Solid-State Circuits Conference in Philadelphia Feb. 10-12. Five technical papers will be presented on the subject; six representatives from electronics firms and two from universities are expected to discuss different approaches to the problem of component density. Other highlights: sessions on tunnel diodes (ELECTRONICS, p 32, Jan. 1) and thin films.

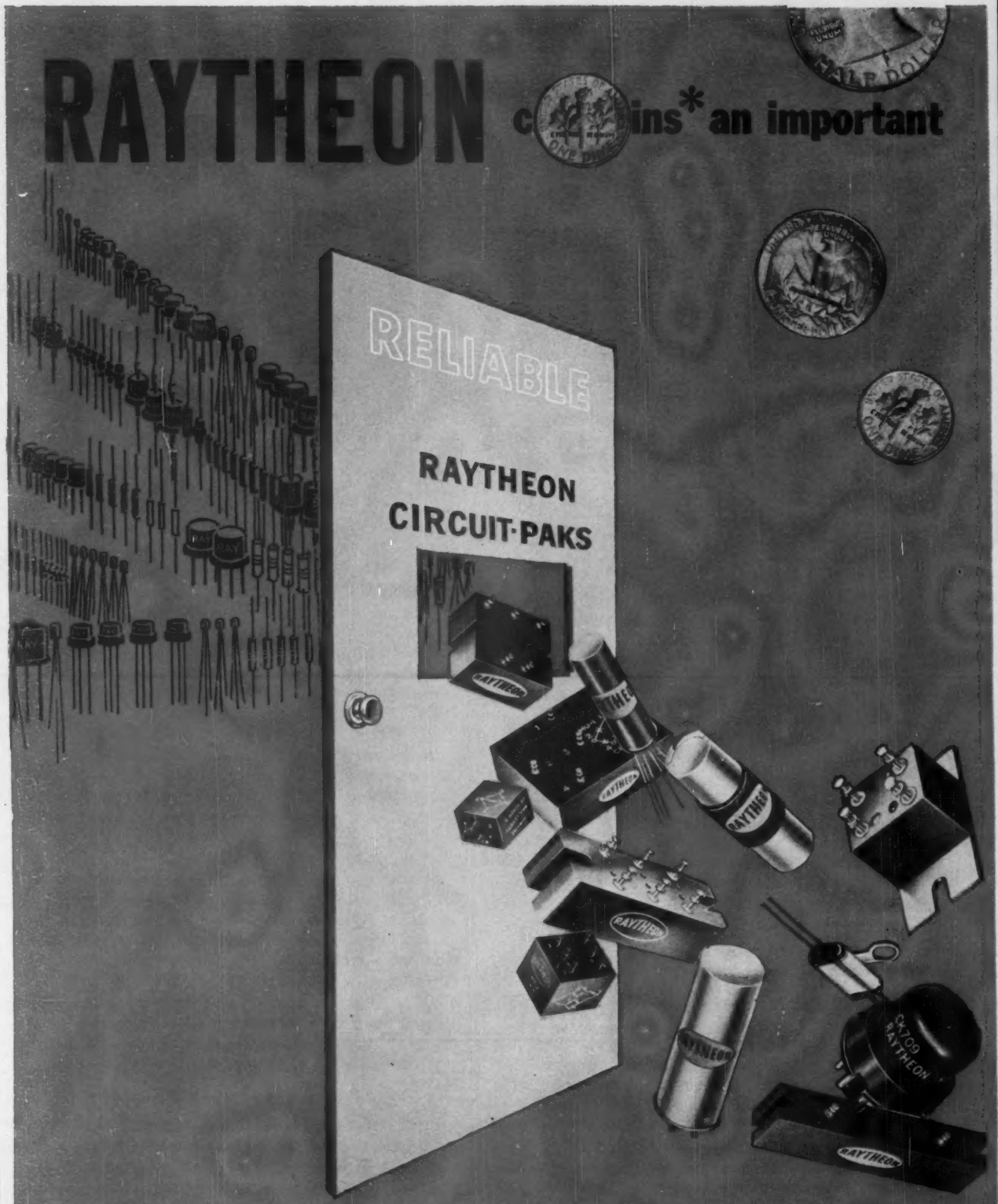
Soviet semiconductor production rate in 1965, the last year of the current seven-year plan, will be 205 times the output in 1950, according to Tass. Computer production is slated to increase by 4.7 times in 1965 over 1959.

Semiautomatic silicon crystal-growing furnace which is said to triple the production capacity of conventional furnaces will be marketed by Hoffman Electronics Corp. Four of the units can be operated at one time by a technician, with furnace operating cycles automatically controlled. Cost: about $12,500.

Increasing U. S. demand for its f-m transistor radios, says Sony Corp. of Japan, will boost its monthly exports to the U. S. from 3,000 to 10,000 starting in March.

U. S. forces in Japan, whose garrison status has been extended by the mutual security treaty signed last week in Washington, will be supplied with a 24-channel, Japanese-made tropospheric scatter communications system. Nippon Electric will supply $1.9 million worth of gear including 60 transmitters and 72 receivers. System will operate in 2,000-mc band, use parametric amplifiers, 33-ft parabolic antennas and permit expansion of transmission capacity to 60 channels.

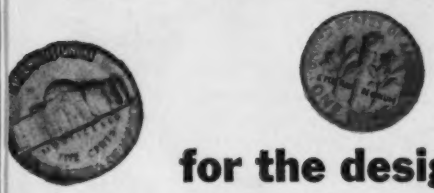
RAYTHEON coins* an important



* E PLURIBUS UNUM (*one unit composed of many parts*) aptly describes Raytheon Circuit-Pak.

new word for designers and producers . . .

CIRCUIT-PAK

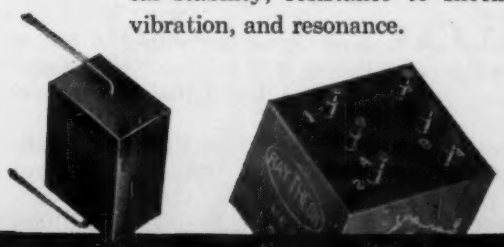


for the designer

1. **Space** — compact, encapsulated subassemblies assure maximum space utilization.
2. **Insulation** — better *internal* electrical insulation between circuit elements; better *external* insulation. Corona is minimized.
3. **Matching** — components may be electrically matched, then assembled or replaced as a single unit.
4. **Stability** — temperature stability in critical circuits is improved.
5. **Environment** — greater mechanical stability, resistance to shock, vibration, and resonance.

for the producer

1. **Maintenance** — input and output are quickly checked; circuits may be readily replaced.
2. **Inventory** — one item to buy and stock instead of multiple items.
3. **Assembly** — just plug it in and put it to work; many Circuit-Paks are available from stock.
4. **Design** — save time with Circuit-Paks that meet your specifications; they are ideal for applications such as comparators, bridges, choppers, flip-flops.
5. **Testing** — Raytheon Circuit-Paks are factory pre-tested — your test requirements minimized.



RAYTHEON

SEMICONDUCTOR DIVISION

RAYTHEON COMPANY

SILICON AND GERMANIUM DIODES AND TRANSISTORS · SILICON RECTIFIERS · CIRCUIT-PAKS

New York, Plaza 9-3900 • **Boston,** Hillcrest 4-6700 • **Chicago,** NAtional 5-4000 • **Los Angeles,** NOrmandy 5-4221 • **Orlando,** GArden 3-1553

Syracuse, HOward 3-9141 • **Baltimore,** SOuthfield 1-0450 • **Cleveland,** Wilson 1-7716 • **Kansas City,** PLaza 3-5330 • **San Francisco,** Fireside 1-7711

Canada: Waterloo, Ont., SHerwood 5-6831 • **Government Relations:** Washington, D. C., METropolitan 8-5205

Dependable performance is the greatest asset of Royal coaxial and multi-conductor cables. They are made to exacting standards for exacting applications. Whatever your requirements . . . for electronic equipment, the military, or community TV applications, Royal can supply stock or special constructions with built-in satisfaction.

Ask for Bulletin 4C-3-L (stock constructions) or let us quote on your needs . . . representatives coast to coast.

ROYAL ELECTRIC CORPORATION
301 Saratoga Avenue
PAWTUCKET • RHODE ISLAND
In Canada: Royal Electric Company (Quebec) Ltd., Pointe-Claire, Quebec

ROYAL ELECTRIC
... an associate of

WASHINGTON OUTLOOK

HOUSE ARMED SERVICES Committee, which made big headlines last year with an investigation into alleged influence-peddling on defense contracts, has come out with its report. It calls for changes in the conflict-of-interest laws to tighten restrictions on retired military brass employed by defense contractors. But the proposals are not so widesweeping as might have been expected from the tone of the committee's probing.

Special Investigations subcommittee chairman F. Edward Hebert (D., La.), who ran last year's show, wants a two-year ban on retired regular officers' selling to any military service, with criminal penalties for violations. Present rules ban selling only to the officer's own former service. And in many cases—notably in the Navy—the penalty is simply the withholding of government retirement pay.

"Sales" have been interpreted very narrowly. The rules at present forbid only direct selling which involves actual contract negotiations. Hebert wants to broaden the definition of selling to include such things as preparation of proposals and performing of spadework on submission of bids.

Under proposed new rules, the case of former Chief of Naval Operations Fechteler—cited by Hebert—would be considered a violation. Fechteler arranged for General Electric's exhibition of a weapons-system scheme before defense officials. Under present rules an activity like this is not considered direct salesmanship.

- **Hebert has introduced a bill** which incorporates many of the committee's recommendations. But it omits the language that spells out what sales efforts on defense contracts constitute. The language is included in the report; Hebert surprisingly shied away from putting it into legislation.

  The bill will probably sail through Congress, but it is not likely to present any significant problems to defense producers who employ former military officers—at least, not as it is now written. Says Hebert: "We're not kidding ourselves. Industry, with its Philadelphia lawyers, will find ways of getting around this."

  Hebert's report lists 1,400 retired officers of field or flag rank who are on the payrolls of the 72 top Pentagon contractors.

- **Electronics producers show up more prominently** than ever in the Pentagon's latest roster of leading defense contractors.

  The new list covers fiscal 1959, includes 100 companies that accounted for 73.8 percent of the $22.6-billion worth of new orders.

  Of this sum, 64 percent of the value of contracts over $500,000 went for aircraft and missiles—much of it representing electronic apparatus—and another 11 percent went for so-called pure electronic projects.

  The top five companies are General Dynamics, with $1.6 billion in contract awards for the year; Boeing, $1.2 billion; North American Aviation, $1 billion; General Electric, $914 million; and Lockheed, $898.5 million.

  Other prominent electronics firms listed include Hughes Aircraft, number 9 on the list, with $494 million; AT&T, 10th, $476.5-million; Sperry Rand, 12th, $403.2 million; Raytheon, 13th, $392.6-million; IBM, 17th, $276.9 million; Bendix Aviation, 18th, $271.3 million; Westinghouse, 19th, $238 million; RCA, 22nd, $199.7 million; Avco, 23rd, $183.7 million; IT&T, 26th, $139.1 million; Burroughs, 29th, $120.9 million; Collins Radio, 30th, $114.9 million; Minneapolis-Honeywell, 32nd, $104.6 million; Thompson Ramo Wooldridge, 33rd, $102.5 million; American Bosch Arma, 35th, $101.5 million; Philco, 37th, $95.9 million, and General Precision Equipment, 47th, $72.7 million.

Electronics Capital...

Growth Catalyst for the Electronics Industry

We are investing long-term sympathetic capital in electronics companies offering the greatest growth potential. Our institution brings to the financial scene the ability to convert electronics technical genius into economically sound and profitable industrial enterprises.

Through our specialized experience in the electronics industry, we bring together in electronics companies the necessary economic, technical and financial elements which will best encourage their rapid growth.

Our $16,500,000 institution, the nation's largest and first publicly held Small Business Investment Company, devotes all of its resources to America's Number One growth industry – Electronics!

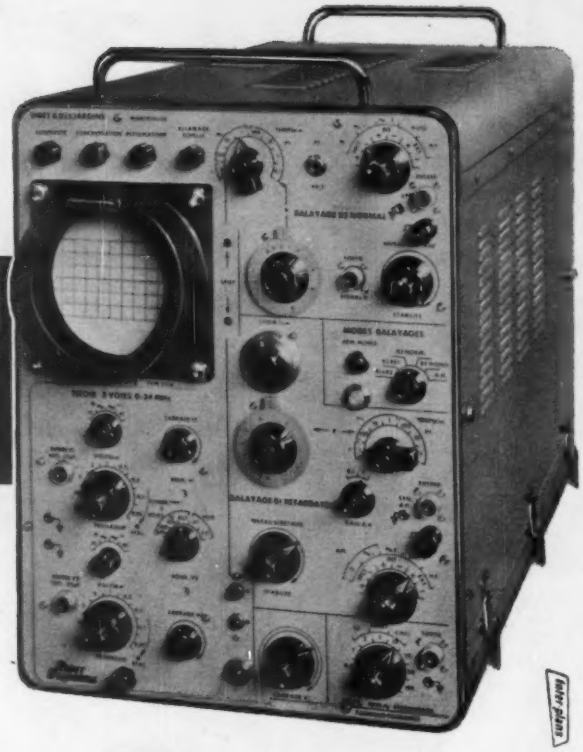
ELECTRONICS CAPITAL CORPORATION

Write for our brochure

1400 FIFTH AVE., SAN DIEGO 1, CALIFORNIA

NUCLEAR ENERGY
COMPUTERS
RADAR

RIBET DESJARDINS
SYNCHROSCOPE 251 A



This high performance synchroscope meets all laboratory requirements, particularly in the field of short impulses, whether repeated or not. It is provided with three plug-in preamplifiers.

CHARACTERISTICS

Flat faced cathode ray tube - Ø = 5" - Usable area 10 x 5 cm
Accelerating potential = 10 KV.

Time Base providing 2 sweeps

Delaying sweep : 7 positions calibrated from 10 sec/cm to 1 µs/cm.

Normal sweep : 8 positions calibrated from 10 sec/cm to 0,1 µs/cm and reaching up to 0,02 µs/cm if expanded five times.

Single shot for all normal sweep.

Horizontal amplifier 0-300 KC/S (- 3 dB) - Sensitivity 0,25 V/cm - Direct calibration.

Plug-in unit T 130 - 1 channel

Passband	Rise Time	Sensitivity
0 - 30 MC/S (- 3 dB)	= 0,012 µs	= 50 mV/cm
5 C/S - 20 MC/S (- 3 dB)	~ 0,020 µs	~ 5 mV/cm

Plug-in unit T 224 - 2 channels by electronic switch

Passband	Rise Time	Sensitivity
0 - 24 MC/S (- 3 dB) 10 C/S - 24 MC/S (- 3 dB)	0,015 µs	= and ~ 50 mV/cm

All high impedance attenuators provide nine calibrated positions.
Delay line 0,1 µs.

Differential pre-amplifier : sensitivity 1 mV/cm - Passband 500 KC/S approx.

Chassis in welded light alloy.

Net weight 90 lbs.

For detailed specifications on this instrument, or on any other RIBET-DESJARDINS products, apply to :

RIBET DESJARDINS

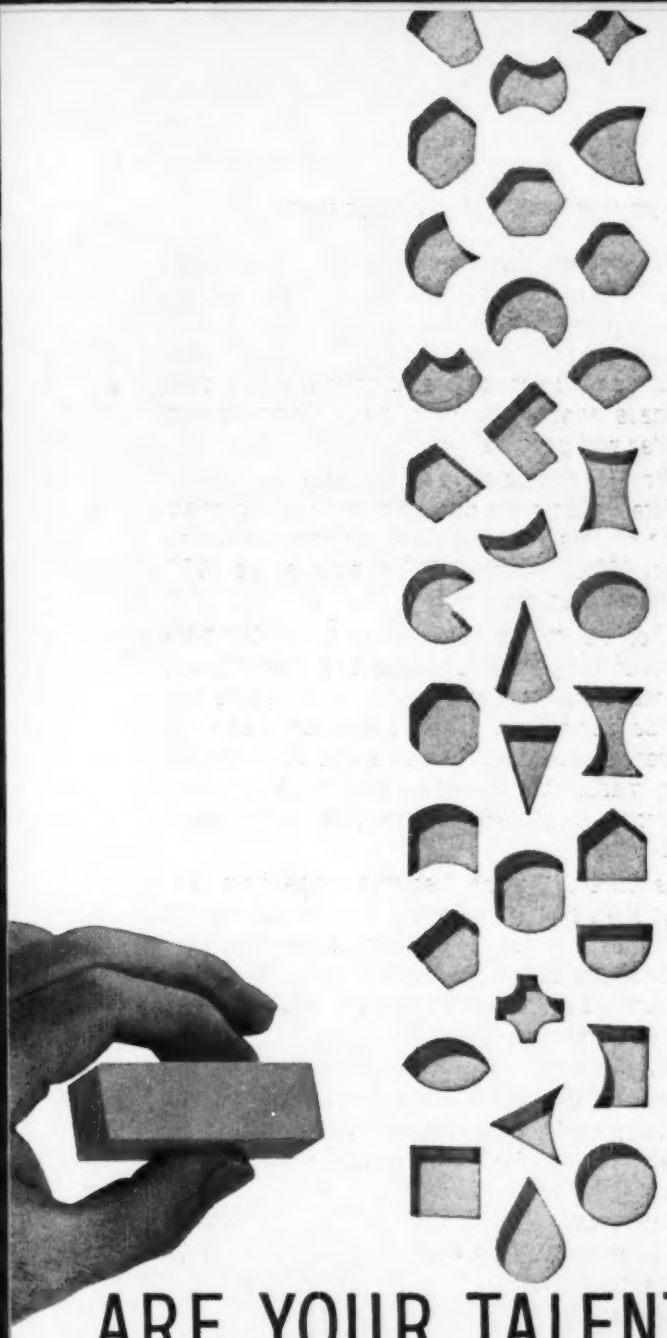
MEASURE & CONTROL DEPARTMENT
13-17, rue Périer, Montrouge (Seine) - France
Tel. ALE. 24-40 + - CABLE ADDRESS : PILACELECT MONTROUGE

Agencies throughout the world :

North America (Canada) : ELECTROLINE TELEVISION EQUIPMENT INC. Room 114, 5757 Decelles Avenue - MONTREAL
Other areas : addresses sent on request

←CIRCLE 15 ON READER SERVICE CARD

CIRCLE 16 ON READER SERVICE CARD



ARE YOUR TALENTS BEING RECOGNIZED?

Hughes-Fullerton's unique, new Professional Capabilities Register insures recognition of all your abilities

Creating a new world with ELECTRONICS

HUGHES

© 1969, HUGHES AIRCRAFT COMPANY

FULLERTON-RESEARCH & DEVELOPMENT

Please turn the page for information on the new Hughes-Fullerton Professional Register

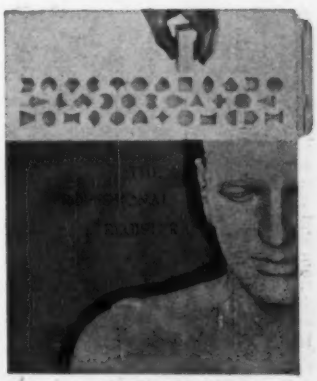
First Class
Permit No. 358
Fullerton, Calif.

BUSINESS REPLY MAIL
No postage necessary if mailed in the United States

POSTAGE WILL BE PAID BY

HUGHES-FULLERTON RESEARCH & DEVELOPMENT
Hughes Aircraft Company
Building 600, Room: B-149
Fullerton, Orange County, California

Attention: Manager, Professional Placement E



If you would like to know more about Hughes-Fullerton and participate in the new Professional Capabilities Register, please return this post-paid card, today.

PROFESSIONAL REGISTER EMPLOYMENT INQUIRY *(Strictly Confidential)*

Please complete this card, fold, staple and mail. The information you give constitutes the first phase of the Professional Register Program and will enable our professional staff to make a preliminary evaluation of your abilities. All inquiries will be answered immediately. When you complete the Program, the inventory of your talents and capabilities will be recorded on over 20 electronic data-cards available for instant use in guiding your future progress at HUGHES-FULLERTON.

Name_____

Address_____

City_____ State_____ Telephone_____

Education:	BS	MS	PhD	Date (s):		BS	MS	PhD	Date (s):
EE	☐	☐	☐	_____	Physics	☐	☐	☐	_____
ME	☐	☐	☐	_____	Other:_____	☐	☐	☐	_____
Mathematics	☐	☐	☐	_____	_____	☐	☐	☐	_____

School (Highest Degree)_____

FOLD

AREAS OF PROFESSIONAL EXPERIENCE:
(please check boxes)

- ☐ Computers
- ☐ Electron Tubes
- ☐ Electronic Circuitry
- ☐ Telemetry
- ☐ Circuit Theory
- ☐ Radar
- ☐ Power Generation
- ☐ Power Transmission
- ☐ Servomechanisms
- ☐ Microwaves
- ☐ Solid State Physics
- ☐ Electromechanical Systems
- ☐ Other:_____

FUNCTIONS PERFORMED:
(please check boxes)

- ☐ Research
- ☐ Development/Design
- ☐ Technical Writing
- ☐ Project Management/Supervision
- ☐ Administrative Staff Support
- ☐ Systems Analysis
- ☐ Testing/Process Control
- ☐ Product Engineering
- ☐ Field Engineering
- ☐ Operations Research
- ☐ General Engineering
- ☐ Systems Engineering
- ☐ Other:_____

Are your talents being recognized?

Most engineers have had to face an unpleasant fact. Often an employer will hire from outside to fill a supervisory post. Entirely qualified men "inside" are passed over. The problem is generally one of communication. The employer simply does not have adequate knowledge of his employees' abilities and promise.

Hughes-Fullerton's new Professional Capabilities Register reflects the complete engineering-orientation of this fastest-growing Hughes activity. (From 800 to nearly 6,000 people since 1957. Planned, *scheduled* growth.)

The Register makes instantly available a complete record of every individual's abilities, interests and accomplishments. Previously hidden talents can now be put to use. Often these can mean the difference when reassignments or promotions are being made. Your potentials become a very real resource of Hughes-Fullerton Research and Development Staff.

Areas covered in the Register range from language skills through patents to books and articles published. It includes teaching experience, professional affiliations. All data is kept up-to-date and handled by automatic data processing equipment for utmost efficiency.

Hughes-Fullerton's philosophy of giving precedence to the needs of engineers has worked well. Hughes-Fullerton was first with three-dimension radar...a major breakthrough in the state of the art. Other vital areas of interest include advanced data processing and electronic display systems.

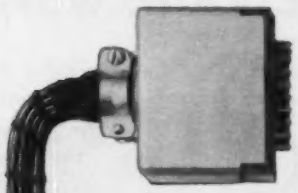
These are a few reasons why you should investigate Hughes-Fullerton. Openings exist at several experience levels for a variety of engineering specialties. For full information fill out the post card and mail it today!

Creating a new world with ELECTRONICS

HUGHES

FULLERTON RESEARCH & DEVELOPMENT
FULLERTON, ORANGE COUNTY, CALIF.

Thanks to you . . .
CTI SETS A NEW STANDARD FOR WIRING-HARNESS TESTERS



After carefully reviewing customer requests received during the past few years, CTI has designed an automatic tester incorporating every feature desired by the manufacturer or user of wiring harnesses and cables. Compact, inexpensive, and simple to operate, the new Model 165 Cable Tester can handle the most complex wiring test problems. Test capacity can be increased indefinitely by adding small switch-unit modules to the basic equipment.

Only the CTI Cable Tester offers all these features:

- Completely automatic
- Simple operation, go/no-go readout
- Simultaneous continuity, leakage, and hi-pot measurements on each test
- Leakage measured from the circuit under test to all others
- Self-testing and fail-safe — validity of tests is assured
- Wide choice of test parameters from calibrated, front-panel controls
- Simple programming without complex patchboards
- Branch circuits can be programmed without sacrificing additional test points
- Precision bridges assure accuracy and stability of measurements
- Provides control of relays in the circuit under test
- Accessory printer lists rejects
- Manufactured by a company that has pioneered automatic testing

SPECIFICATIONS

Continuity test currents: Off, 0.1, 0.5, 1.0, and 2.0 amps d-c

Continuity accept limits: 0.1, 0.5, 1.0, 5.0, and 10.0 ohms (maximum test current on the 1-, 5-, and 10-ohm ranges is 1.0 amp.)

Hi-pot voltages: Off, 28, 100, 500, 1000, and 1500 volts d-c (hi-pot current limited to approximately 1 ma)

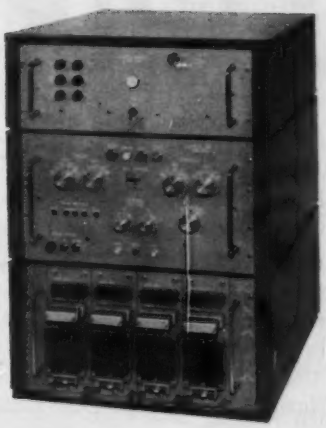
Leakage-resistance limits: 1, 5, 10, 100, and 500 megohms

Hi-pot dwell time: continuously variable from 0.2 secs to 100 secs

Test rate (maximum): 5 circuits per second (0.2 seconds dwell time)

Test capacity: 200 tests plus 200 for each complete, additional Switching Unit used. Switching Unit panel may be supplied with 50-test switch modules as needed.

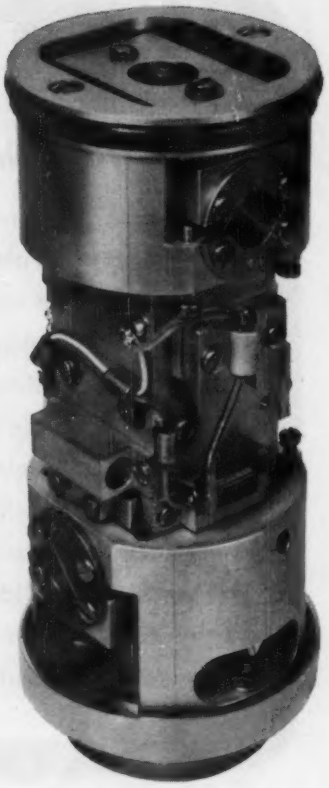
Each of the above test parameters can be selected independently of the others. All values are set with front-panel selector switches.



Engineers: Career opportunities are currently available at CTI

CALIFORNIA TECHNICAL INDUSTRIES
DIVISION OF TEXTRON INC.
BELMONT 8, CALIFORNIA
Foremost in Automatic Testing

actual size



actual size

new dual-axis miniature d-c rate gyro

A miniaturized Humphrey dual-axis rate gyro only 4 inches long and 1¾ inches in diameter saves space and reduces cost by doing the work of two gyros. It may be used to measure rates about two different axes, such as pitch and yaw in a missile.

Features include center flange mount, hermetically sealed steel case; rate ranges from 50 to 2000 degrees per second; precision potentiometer output; all metal pot construction for high level excitation and powerful output signal; up to 2 watts dissipation in pot; excitation voltage up to 60 volts; can be furnished with 28-volt d-c or 12-volt d-c motor. Also available as single axis unit with shorter length. For more information, write Humphrey, Inc., Dept. E-10, 2805 Canon St., San Diego 6, Calif.

Humphrey Inc.

ELECTRO-MECHANICAL INSTRUMENTS

GYROSCOPES, ACCELEROMETERS, POTENTIOMETERS
WHEN OTHERS CAN'T—HUMPHREY CAN!

New Stock Split Planned

TWO-FOR-ONE stock split has been approved by **Westinghouse Electric** stockholders to become effective on Feb. 9. Split was recommended in the fall of last year when quarterly dividends went from 50 to 60 cents per share after reports of the highest third quarter earnings in the company's history. The increase will raise to 50 million shares the 25 million now outstanding. Par value will go from $12.50 to $6.25.

• **Republic Foil,** Danbury, Conn. manufacturer of aluminum foil for electrolytic capacitors and packaging reports sales of more than $5 million for 1959. The total in 1958 was slightly over $4 million. The company plans to open a new plant next month in Salisbury, N. C.

• **Telecomputing Corp.,** Los Angeles, announces that an offer has been made to buy **Narmco Industries, Inc.,** San Diego, Calif. for $7 million in stock. Telecomputing would exchange 497,000 shares of stock for all outstanding Narmco stock if the transaction goes through. Final decision is expected next month. Narmco manufactures adhesives and hardware for aircraft and missile applications.

• **Itek Corp.,** Waltham, Mass. plans to hold stockholders meeting in Boston on Feb. 9. The company reports income from sales and services of approximately $25 million in fiscal 1959 as compared with $3,464,000 for fiscal 1958. Anticipated net earnings per share in fiscal 1959 are expected to run at approximately 57 cents per share on the 833,797 shares that are now outstanding.

• **General Instrument Co.,** Newark, N. J. reports a rise of $1,378,233 for the fiscal year just ended as compared with the previous fiscal year. Sales for the period were at a record $41,277,875, and backlog stood at $33,238,000, highest in the company's 37-year history. Per-share earnings were 90 cents on 1,529,473 shares compared with last year's earnings of 70 cents a share on a slightly lower number of shares.

• **Servo Corporation of America,** Hicksville, N. Y. announces acquisition of **Electro-Pulse, Inc.,** Culver City, Calif. subject to approval of the California Corporations Commissioner. The West Coast firm manufactures long-time delay generators, precision pulse generators and related equipment. Sales for Electro-Pulse were $800,000 in 1959. Details of the acquisition were not disclosed.

• **United Components, Inc.,** Orange, N. J. reports sales of $91,640 for the Sept.-Nov. period of 1959 as compared with $65,689 in the five preceding months. Gross profits for the former period were $16,676, and for the latter, $11,665. Stockholders voted last week to increase to 1 million the number of shares outstanding.

25 MOST ACTIVE STOCKS

WEEK ENDING JANUARY 15

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Ampex	902	109½	97½	105
Gen Electric	870	96⅝	91⅝	93¾
Avco Corp	816	14⅞	14	14⅛
RCA	806	[illegible]	63	65⅛
El-Tronics	784	1⅞	1½	1⅝
Sperry Rand	767	24¾	23⅝	23⅝
Int'l Resistance	703	25⅛	21⅛	24
Reeves Soderit	608	11⅛	9¾	10⅝
Collins Radio	570	64⅝	60	63
Gen Dynamics	562	53⅜	50⅛	50⅞
Elec & Mus Ind	545	11¼	10⅛	11¼
Int'l Tel & Tel	516	37⅛	35⅞	36⅜
Univ Control	512	18¼	17⅛	17⅞
Litton Ind	512	62	57⅜	60⅛
Philco Corp	504	32¼	29⅝	31⅜
Raytheon	477	51¾	50	50⅛
Gen Tel & Elec	466	83	80⅛	82
Texas Inst	384	169½	159½	168
Westinghouse	338	109⅞	102⅞	106
Computyne	310	13⅝	11¾	13
Lear Inc	309	19¼	18½	18½
Spartan Corp	267	9½	8½	8⅝
Varian Assoc	266	43¼	39¾	41⅜
Loral Electronics	261	44⅝	38⅝	44
Dynamics Corp	237	12	11¼	11⅜

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

CerMac

SPECIALTY SEALS precision-made to your specifications

High-temperature specialty seals vacuum-tight, shock- and vibration-proof

A competent, dependable source for custom seals is CerMac (Ceramic-Metal Assemblies Corporation). Here experienced and skilled personnel employ modern precision manufacturing facilities to produce hermetic seals and other metallized ceramic assemblies of highest quality with prompt deliveries. Send drawings for quotations.

Representatives in principal cities

SHAW INSTRUMENT CORPORATION
Successor to
CERAMIC-METAL ASSEMBLIES CORP.
P.O. Box E-328 Latrobe, Pennsylvania
Phone: Latrobe, Keystone 9-1757

NEED PRODUCT INFO? LOOK IN THE NEW

electronics BUYERS' GUIDE

You'll find detailed facts about the products of almost 700 different advertisers – that's 42% more than you'll find in any other electronics directory.

There's also 64 pages of reference data about markets, materials and design – vital information for all working in electronics. Also local sales offices of manufacturers . . . the names, addresses and phone numbers of representatives . . . complete lists of manufacturers . . . registered trade names . . . and also, of course, the most complete listing of all electronic and related products. Tells what you want to know . . . *when you're ready to buy.*

A McGraw-Hill Publication • 330 West 42nd Street, New York 36, New York

Engineers make true neighbors

Lucky is the man who has engineers for neighbors!... For engineers, as all who are trained in the sciences, hold precious the rights of individuals. They respect the privacy of others. They have a wholesome social conscience... for, after all, the essence of their work is the betterment of mankind. Engineer-neighbors are quick to lend a hand.

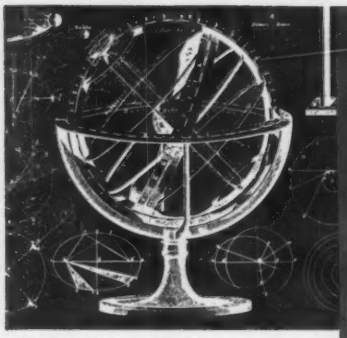
Engineers' homes are invariably a credit to the community, for engineers take pride in what they do, just as in business. They're thorough, particular, precise... forever demanding the best.

We're engineers ourselves, so we know what it means to be a true neighbor. When we get a request for help or information, we're quick to lend a hand. Try us.

... helping engineers make the best, by supplying the best

GENERAL TRANSISTOR CORPORATION

91-27 138th Place, Jamaica 35, New York



Back at the earth terminal..

DOUGLAS AIRCRAFT COMPANY
MISSILES AND SPACE SYSTEMS

has immediate openings in the following fields—

Electrical and Electronics:
Control System Analysis & Design
Antenna & Radome Design
Radar System Analysis and Design
Instrumentation
Equipment Installation
Test Procedures
Logic Design
Power System Design

Mechanical Engineering—
Analysis and Design of the following:
Servo Units
Hydraulic Power Systems
Air Conditioning Systems
Missile Launcher Systems
Propulsion Units and Systems
Auxiliary Power Supplies

Aeronautical Engineering:
Aerodynamic Design
Advanced Aerodynamic Study
Aerodynamic Heating
Structural Analysis
Strength Testing
Dynamic Analysis of Flutter and Vibration
Aeroelasticity
Design of Complex Structure
Trajectory Analysis
Space Mechanics
Welding
Metallurgy

Physics and Mathematics:
Experimental Thermodynamics
General Advanced Analysis in all fields
Computer Application Analysis
Computer Programming and Analysis
Mathematical Analysis

For full information write to:

Mr. C. C. LaVene
Box 620-F
Douglas Aircraft Company, Inc.
Santa Monica, Calif.

MARKET RESEARCH

Semiconductor, Tube Markets

YEAR 1960 will see substantial increases in sales of semiconductors and maintenance of high level 1959 sales of electron tubes, predicts L. Berkley Davis, general manager of the electronic components division of General Electric. Sales estimates represent domestic production only.

Semiconductor sales total will advance from $400 million in 1959 to $550 million this year, an increase of 37 percent, Davis says.

Transistors

He expects dollar sales of transistors in 1960 to gain 40 percent over 1959 and unit sales to gain 53 percent. Dollar sales will mount from $225 million to $315 million while unit sales advance from 85 million to 130 million. Average unit price is expected to decline from $2.65 in 1959 to $2.42 in 1960.

Market division of transistor sales predicted for 1960 is: consumer $45 million, industrial $120 million, military $150 million.

Semiconductor rectifier sales will increase by about 18 percent in 1960, with sales of low-current germanium and silicon types accounting for almost half the total.

Diode sales are expected to total $110 to $120 million in 1960 while a miscellaneous group of semiconductors including solar cells, infrared and zener devices are expected to produce $15 million to $25 million in sales.

Much experimental use of tunnel diodes is looked for in 1960, but samples will be limited to small quantities pending the development of circuits, says Davis.

Receiving Tubes

Domestic manufacturers will produce 415 million tubes worth $345 million, Davis estimates. However, about 435 million receiving tubes will be placed in service. Imports will account for the difference.

Sales of commercial tube types will amount to about $275 million, with over half in the renewal market. Tv set manufacturers, who will buy nearly 100 million domestic receiving tubes, will take the bulk of the tubes that go into the original equipment market.

High reliability receiving tubes for aircraft, industrial and military equipment will generate approximately $70 million worth of sales, with about 70 percent of the volume purchased by manufacturers of new equipment. Sales in 1960 of industrial and military tubes for replacement purposes will increase approximately 13 percent over 1959 to a total of $9 million.

Power Tubes

Power tube sales in 1960 will reach a new high of $300 million as sales continue to increase at a rate of 10 percent.

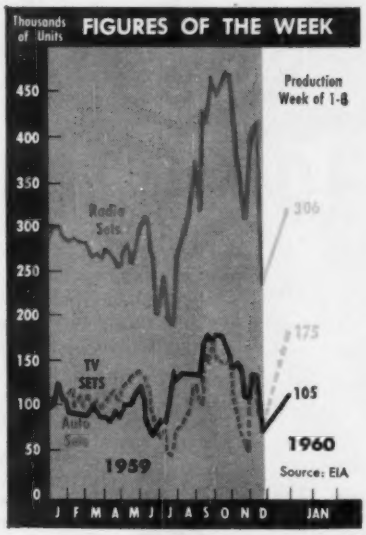
The greatest increase will be in sales of tubes to the military which will use more of them in space weapons, defense, detection and control systems and in communications.

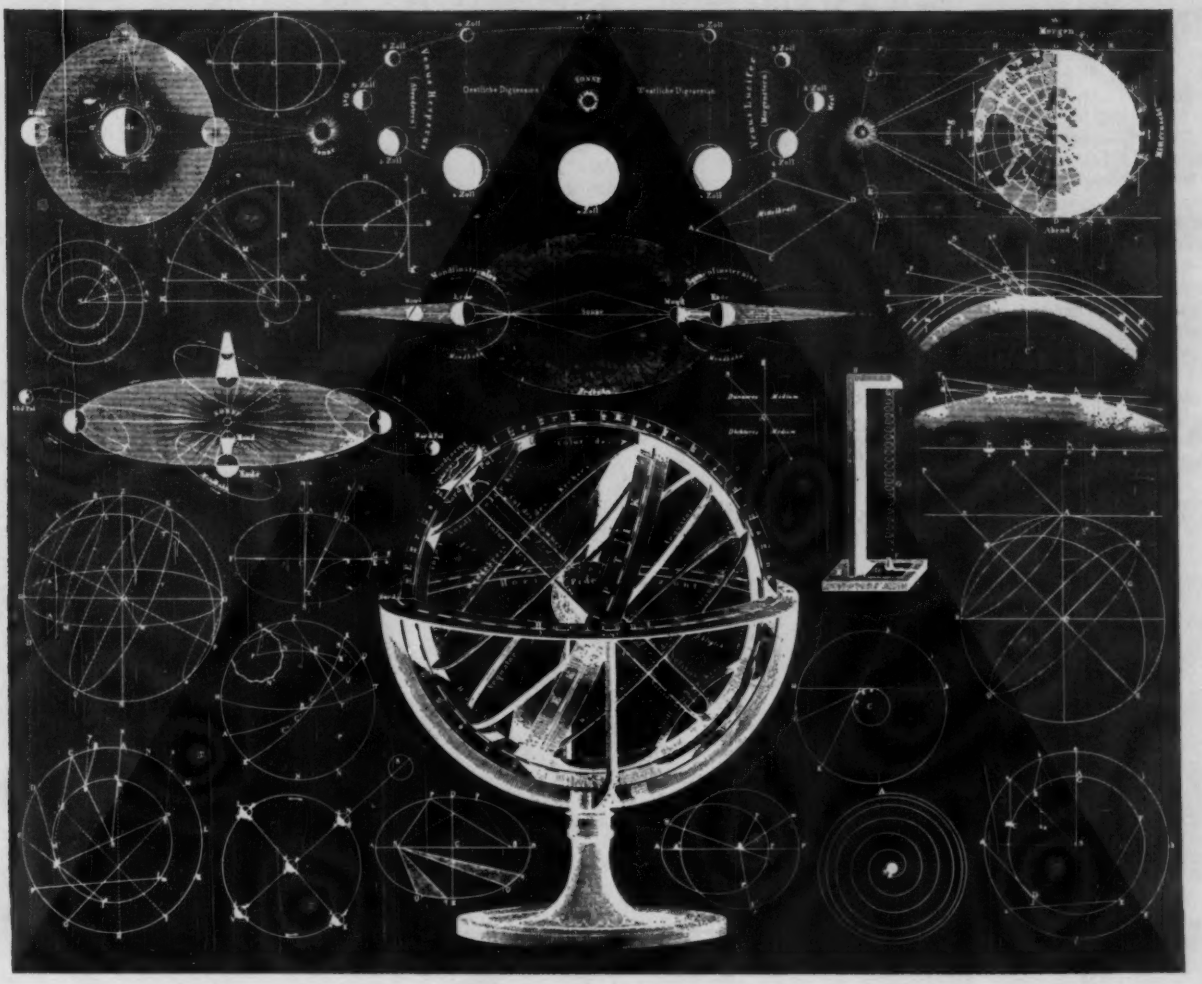
Demand for power tubes for industrial applications in 1960 will hold steady. Use of ignitrons and thyratrons may yield to pressure of solid-state devices, Davis says, but good demand for tubes in many new uses can be expected.

Cathode-Ray Tubes

Nearly 13 million tv picture tubes will be sold for approximately $260 million during 1960, an increase of five percent over 1959.

More than half of 1960's sales will be used for replacement, the remainder in new television sets.





Guided tour of the solar system

The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects. Some of our requirements are listed in our column on the facing page.

Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS

MISSILE AND SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ DC-8 JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND SUPPORT EQUIPMENT

WHAT IS THE RECORD BEHIND HOFFMAN TRANSISTORS?

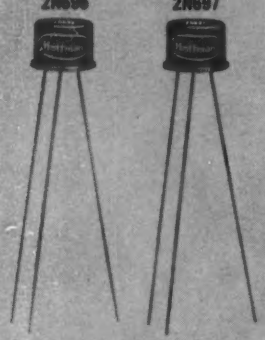
1 ■ MORE EXPERIENCE IN SILICON TECHNOLOGY.

For seven years—practically the full span of semiconductor history—Hoffman Semiconductor Division has worked exclusively with silicon devices. Company achievements include the world's first commercial silicon diodes, zener diodes and solar cells. Hoffman makes the most extensive line of silicon devices in the industry.

2 ■ MORE EXPERIENCE IN DIFFUSED-JUNCTION DEVICES.

The diffused-junction concept, one of the most important in transistor technology, was adapted by Hoffman as early as 1955. To date, the company has produced over five million diffused-junction devices—more than any other company in the electronics industry.

2N696 2N697



For further information and complete technical specifications, contact the factory or your area Hoffman sales engineer.

3 ■ NEW CONCEPT IN QUALITY CONTROL.

Hoffman has developed a completely new quality assurance and quality control concept which will enable the company to ship devices that meet the most stringent military and commercial requirements.

4 ■ RELIABILITY BACKED BY NUMBERS.

Hoffman has made and shipped more than ten million silicon semiconductor devices.

5 ■ A FACILITY DESIGNED ESPECIALLY FOR TRANSISTORS.

Hoffman's new 109,000-square-foot facility was designed especially for the development, production and testing of transistors. It houses extremely advanced equipment, much of it Hoffman-developed.

Hoffman

Hoffman / ELECTRONICS CORPORATION

Semiconductor Division

1001 Arden Drive, El Monte, California

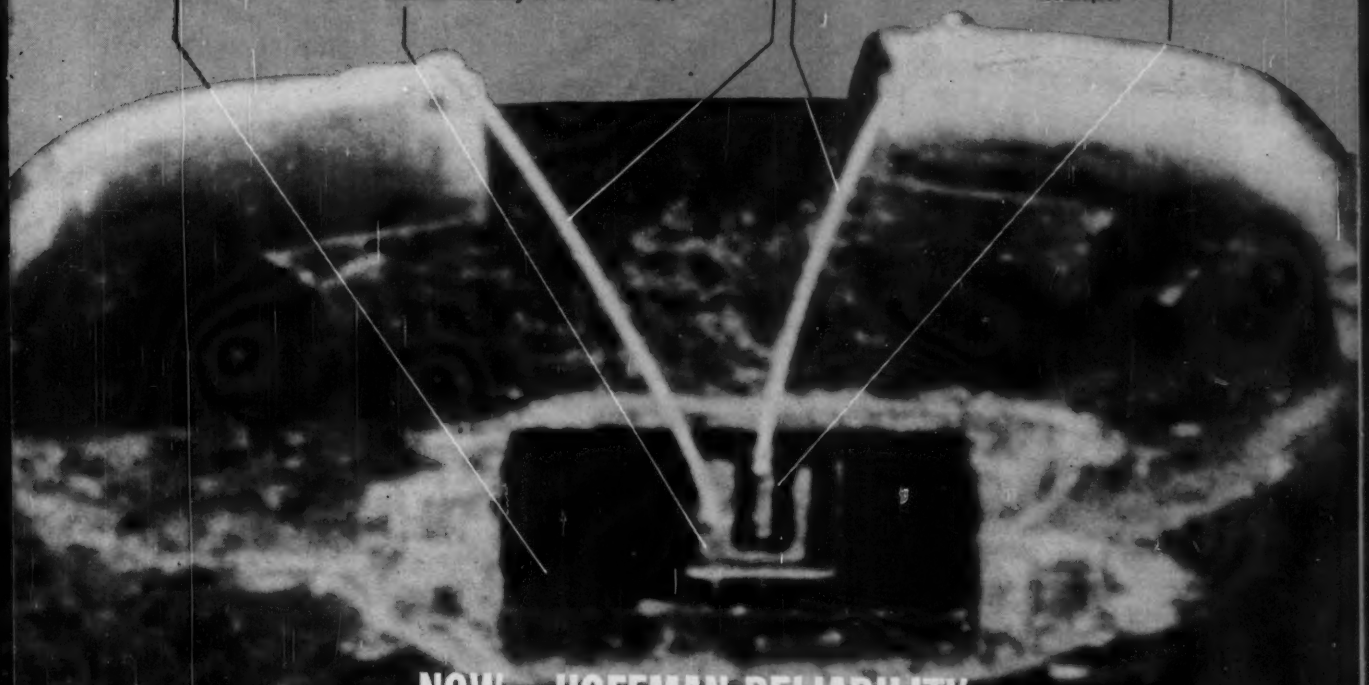
Plants: El Monte, California and Evanston, Illinois

Collector is in electrical contact with case.

Base width is reduced to only one micron by precisely controlled lapping and diffusion techniques to boost frequency handling capability. Silicon slices for these transistors are polished under optical control with an accuracy of 4×10^{-6} inch.

Gold wire bonds to emitter and base are fabricated to withstand 20,000G acceleration. Because parts are so small (wires are only 1/10 the diameter of a human hair), bonding is done under a high-power microscope.

Registration of emitter within U-shaped base makes optimum use of emitter area, results in high efficiency. This configuration is made possible by the precision of the Hoffman photographic registration technique.



NOW...HOFFMAN RELIABILITY IN TRANSISTORS

ANNOUNCING THE HOFFMAN 2N696 AND 2N697 NPN DIFFUSED-JUNCTION DRIFT-FIELD SILICON MESA TRANSISTORS

WITH THREE TIMES THE HIGH-FREQUENCY POWER GAIN OF SIMILAR DEVICES

By increasing the usefulness of the emitter area, Hoffman engineers have boosted the minimum high-frequency gain at large currents to 6 at 20 mc ($I_C = 50$ma, $V_C = 10$V)--more than three times the industry standard. Hoffman's unique base-emitter configuration, coupled with a photographic fabrication technique that offers control accuracy of the order of light wavelengths, has also lifted current and frequency characteristics well above industry specifications. Reasonable current gains at 40mc have been measured. Since the photo process is far more controllable than mechanical fabrication, these transistors have exceptionally uniform characteristics. Stability, too, is outstanding, because Hoffman pre-ages every transistor at 300°C and seals it hermetically in an inert-gas atmosphere.

A wide range of useful current gain and operating frequencies makes these units ideal for computer, radar and many other applications. You can count on them in your most important circuit. Reliability is built into every unit.

ABSOLUTE MAXIMUM RATINGS (25°C)

V_{CBO} Collector-to-base voltage	60V
Total dissipation at case temperature 25°C	2W
Storage temperature range	−65°C to +175°C

ELECTRICAL CHARACTERISTICS (25°C)

SYMBOL	CHARACTERISTIC	MIN.	MAX.	TEST CONDITIONS
h_{FE}	D.C. pulse current gain (2N696)	20	60	$I_C = 150$ma $V_C = 10$V
	(2N697)	40	120	$I_C = 150$ma $V_C = 10$V
V_{BE} (sat)	Base saturation voltage		1.3V	$I_C = 150$ma $I_B = 15$ma
V_{CE} (sat)	Collector saturation voltage		1.5V	$I_C = 150$ma $I_B = 15$ma
h_{fe}	Small signal current gain at f = 20mc	6	9	$I_C = 50$ma $V_C = 10$V
C_{ob}	Collector capacitance		35uuf	$I_E = 0$ma $V_C = 10$V
I_{CBO}	Collector cutoff current		1.0ua	$V_C = 30$V T = 25°C
			100ua	$V_C = 30$V T = 150°C

Physical dimensions in accordance with JEDEC 30 (TO-5). Manufactured to meet MIL-S-19500B requirements.

Navy Plans 12-Man Killer Sub

Human engineering using electronic data processing and display is breeding a new generation of automated submarines

A FULLY automated 12-man submarine moved closer to realization this week. The Navy ends Phase II of its SUBIC (Submarine Integrated Control) program and begins Phase III.

Operation of a highly maneuverable, subsurface attack weapon with only a dozen men (the *USS Nautilus* has a crew of about 100) will be achieved by automation, integration of controls and systematic coordination between man and machine.

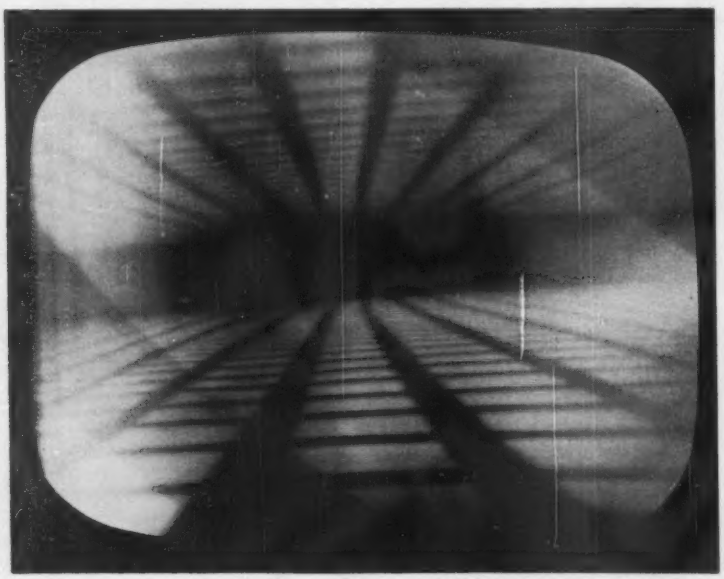
Five fundamental control areas, or "loops," will be automated and integrated: ship control, engineering, communications, weapons control and environmental. These separate control loops are then integrated into a master submarine command control system. Hundreds of bits of digital data will be electronically collated and converted to a simple positional display so that the human action required for maneuvering the sub will be self-evident.

Ideally, one man could handle each of the five control loops in operation under normal conditions. If no torpedoes are being fired, the ship's control operator could also monitor the weapons control loop. In case of emergency, crew members off duty would of course assist the one-man areas where needed.

Initiated in 1958, with General Dynamics' Electric Boat division named prime coordinator, Phase I paved the way by establishing the objectives and the techniques for attaining them. During Phase II, nine subcontractors studied the five control loops, determined the problems, and have come up with suggestions for suitable designs.

Phase III consists of digesting and consolidating the recommendations of the nine subcontractors, testing the proposals in simulated form at Electric Boat's simulation laboratory, in Groton, Conn., and coming up with an initial integrated control concept.

As the design concepts for the various loops get far enough along, new subcontracts will be awarded for specific design details.



Contact analog display shows sub commander electronically-generated picture of his ship's position in water environment

First application of the results of the SUBIC program will go into a new generation of antisubmarine warfare (ASW) killer subs. The *Tullibee*, one of the present generation of killer subs now under construction, will weigh 2,175 tons. SUBIC killer subs will probably weigh less than 1,500 tons. The SUBIC concept, however, is in no way limited by tonnage; it could serve any category of submarine. A later generation of Fleet Ballistic Missile subs might also incorporate the SUBIC design. Eventually such savings in manpower, space and operations costs are expected to be incorporated in all subsurface craft.

Integration of the five control systems into a single master command control console for the commander was the joint responsibility of Melpar, Alexandria, Va., and Human Sciences Research Inc., Arlington, Va. (the latter is still working on certain phases of the subcontract scheduled for completion by July).

Command Console

The control center is the nucleus of the ship's entire system. All information required for command decision flows into a console where it is rapidly integrated, visually displayed on the contact analog display, and continuously revised as changes occur in any segment. The display illustrates the internal status of the submarine as well as its situation in relation to the environment.

The picture presented by the contact analog display is an electronically-generated system of squares. Squares at the bottom represent the bottom of the sea, squares at the top, the surface. The ship's own position is shown as a dark shadow between the two. As the ship approaches the bottom, or the floor of the sea suddenly climbs, the pattern of grids immediately reflects the change in the ship's environment. The commander can thus "see" his

ship's situation and can dispatch command decisions to the five fundamental control areas.

The contact analog display is one segment of the SUBIC program that may lend itself to retrofitting existing nuclear subs.

Ship Control

Librascope, Glendale, Calif., and Cornell Aeronautical Laboratories, Buffalo, N. Y., are responsible for the ship control loop. Librascope's portion of the study will be delivered in March.

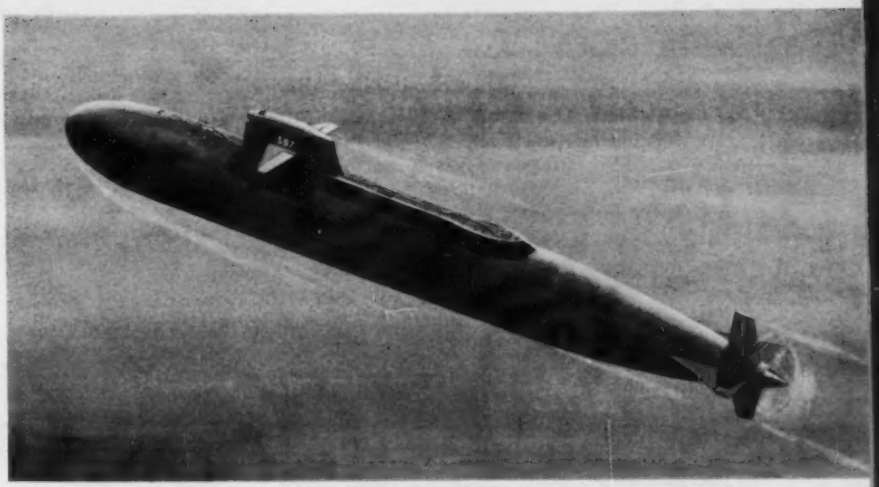
SUBIC promises one-man control of all steering and diving operations. (World War II subs required eight men; new nuclear subs, three.) The operator is assisted by automatic depth, course, trim and buoyancy control mechanisms. A central control computer provides essential information to displays and automatic mechanisms. Status of the sub is continuously revealed by an integrated dynamic display and situation plot.

The ship's control system is now being tested as part of Phase III by simulating electronically all the geographical and physical elements the ship's commander must be conscious of, such as the ocean's surface, floor, and other ships. This information is displayed by closed-circuit tv.

Weapons Control

International Business Machines Corp., Owego, N. Y. is studying the weapons control loop which includes the detection of targets, determination of target location, classification of contacts, precision navigation and firing orders to weapons. IBM's study, to be completed by mid-year, emphasizes the important correlation that exists between weapons control and ship control. This tie-in will be resolved at the command level. Correlation of these controls becomes increasingly vital as submarine missions involve engagement with multiple targets.

Major components of the weapons control loop include: a computer capable of accepting, storing and processing all available information; a display in situation plot form continuously indicating identity, position and movement of multiple targets as well as the sub's own position and movement; visual display of information with an indication of the most feasible type of action to take.



First of forthcoming generation of nuclear killer subs, *Tullibee*, is under construction. Next generation, based on SUBIC, will be fully automated with a crew of 12

Engineering Control

Franklin Institute, University of Pennsylvania, Philadelphia, is working on this phase of the program. Under normal conditions one man will control the main propulsion plant. A single display shows the operator the status of the power plant at all times. The operator is equipped with automatic means of effecting change in operation of the engineering plant for stand-by propulsion, repairs, special conditions or casualty correction. Necessary data is automatically stored and processed.

Communications Control

Study by Westinghouse's Air Arm div., Baltimore, Md., includes both external and internal communication. Subsystems indicated are: automatic transmitter-receiver to provide reliable high-speed transmission with a human operator as monitor and maintainer; automatic encryption-decryption unit to allow rapid receipt and transmission of messages; and rapid-access storage and automatic processing and dissemination of intelligence information and communications received.

Environmental Control

Study by Ionics, Inc., Cambridge, Mass., involved continuous air revitalization and automatic detection, monitoring and elimination of atmospheric contaminants; continuous control of environmental factors which promote maximum human effectiveness; display of casualty status information and controls for effecting corrective action.

Daystrom, La Jolla, Calif., is responsible for a number of the sensors used in the loops: electromagnetic, temperature, force, inertial, physical quantity, and geometry.

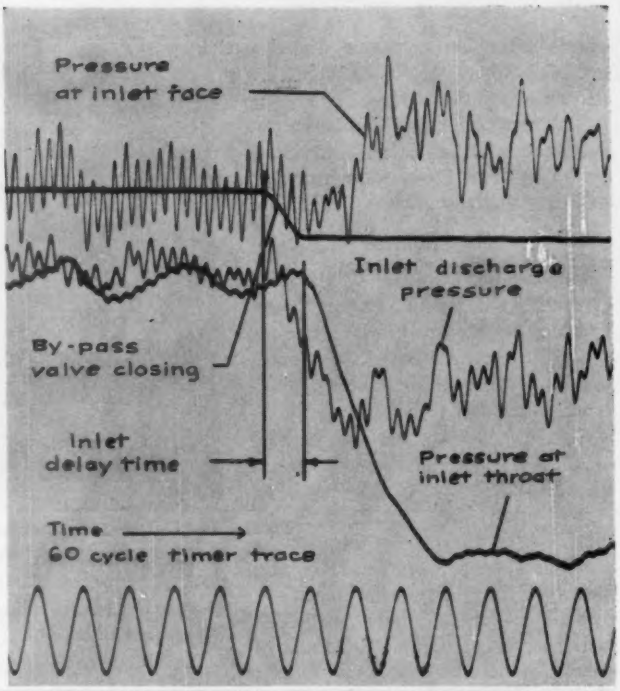
SUBIC, under the administration of the Office of Naval Research, (ONR), is one part of a three-pronged program. ONR also administers a similar program called SURIC (Surface Integrated Control) for surface craft, with Sperry Rand as prime contractor. Army and Navy sponsor ANIP (Army Navy Instrumentation Program) for both fixed wing and helicopter/VTOL aircraft, primed by Douglas and Bell Helicopter.

Objectives for all three efforts are in essence the same: to provide instrumentation, display and control capabilities required to achieve the maximum effectiveness of the operator or pilot-vehicle combination under all environmental conditions.

ONR sees SUBIC as a continuing program. The work will not end with design of a new submarine. New concepts, tested in breadboard models, will be turned over to the Bureau of Ships for use in the fleet's inventory of weapons. While BuShips is turning these into hardware, SUBIC will continue investigating new designs.

In research...

A Model 906 Honeywell Visicorder wrote this record of pressure fluctuations... "buzz"... for engineers at the NASA Lewis Flight-Propulsion Laboratory in Cleveland. "Buzz" is an unsteady variation in the pressure and airflow characteristics of a supersonic aircraft or missile inlet. These Visicorder studies defined the buzz-free operating limits of the inlet, and provided the designers with structural load information in case the inlet were inadvertently caused to operate on buzz during flight. This load information is vital, for inlet buzz can result in fluctuating structural loads of the order of 1000 psf... loads which could cause structural failure of the inlet and loss of the airplane. Visicorder records such as this have played an important role in the design of inlet control systems.

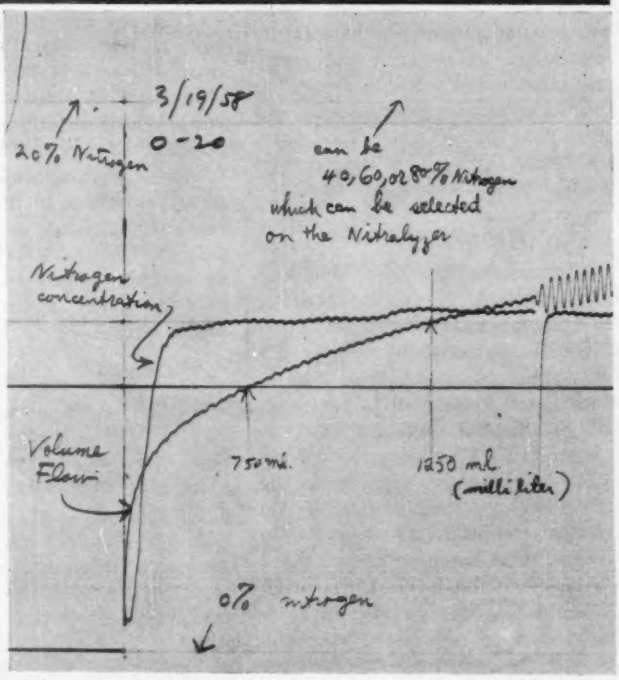


these are records of leadership

In medicine...

This directly-recorded Visicorder chart has told the scientists of the U. S. Public Health Service Occupational Health Program an important story about uneven alveolar ventilation in the human lung during a single breath of oxygen. In these lung function tests, the Visicorder measured anatomic dead space and abnormalities in the distribution of inspired gas in the alveoli of the lungs. The subject, under test, inhaled 100% oxygen to dilute nitrogen in the lungs. The Visicorder recorded the volume and the nitrogen percent of the exhalation. In these and in hundreds of other scientific and industrial applications, Visicorders are bringing about new advances in product design, computing, control, rocketry, nucleonics and production.

For information on applying the unlimited usefulness of the Visicorder to your specific problems, phone your nearest Honeywell Industrial Sales Office.



Visicorder records 2/3 actual size.

The Honeywell Visicorder provides instantly-readable, high-sensitivity data at frequencies from DC to 5000 CPS. There are models with 8, 14, or 36-channel capacities.

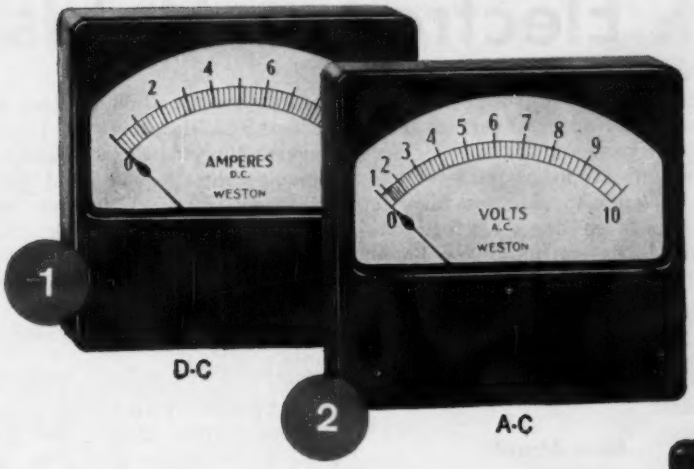
Honeywell

Industrial Products Group

Reference Data: Write for specifications on Visicorders 906B, 1108 and 1012.

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado

Model 961 Group Instruments



Model 741 Group Instruments

Feature by Feature

THESE WESTON RECTANGULARS LEAD THE FIELD

The well-balanced design, fine appearance and desirable features of these Weston instruments reflect a 70-year tradition of fine engineering and craftsmanship. If you're not already well acquainted with these notable models, look over this check list — you'll not find better value anywhere.

For full information, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom International, 100 Empire St., Newark 12, N. J.*

1 2 3 4	**Long scales** (Model 961 Group: 3.17" . . . Model 741 Group: 3.24" A-C and 3.52" D-C)
1 2 3 4	**Excellent natural illumination** (self-contained lighting optional)
1 2 3 4	**High rated accuracies** (Model 961 Group: 2% of full scale value . . . Model 741 Group: 1%)
1 2 3 4	**High sensitivities . . . low response times**
1 2 3 4	**Excellent torque-to-weight ratios**
1 2	**Dielectric test — 5000 volts A-C**
2 4	**Group includes A-C rectifier type instruments**
1 3	**D-C and rectifier type instruments have magnetic shunts for precise adjustment**

These instruments are particularly suitable for a wide variety of specialty applications where other than cataloged accuracies are desirable.

WESTON *Instruments*

A DAYSTROM UNIT

WORLD LEADER IN MEASUREMENT AND CONTROL

CIRCLE 31 ON READER SERVICE CARD 31

New Budget: Electronics Holds

WASHINGTON—FEDERAL SPENDING for electronics in the coming fiscal year (starting July 1) will be held pretty close to last year's figures. The distribution of goods will show up to be different from last year as the various agencies go to Congress for money, but the overall total will not change much. The biggest buyer of electronics, the Department of Defense, has been forced to cut its total buying power slightly in order to keep within the President's budget ceiling of $40.9 billion.

Congress, however, is sure to challenge the administration on its defense efforts and may well hike specific elements of the military budget. Long before the defense budget gets congressional sanction, hearings will probe into the strength of the U. S. relative to the Soviets. And political soundings already indicate many legislators are not happy with the nation's present standing. The so-called U. S. missile and space lag, for instance, is sure to provoke sharp congressional criticism of current aerospace programs.

Individual military leaders, too, will be quick to plug for favorite programs once they get before congressional committees. Air Force officials, for example, are openly critical about having to trim back the B-70 program. They will try to win congressional backing to restore the program to its original schedule.

More Aircraft

Aircraft procurement remains one of the major programs in the current budget. Money has been earmarked for a total of 1,510 craft, of which 633 are for the Air Force, 658 for the Navy, and 219 for the Army. This amounts to 99 more aircraft slated for procurement than were purchased last year, but 224 less than were bought in fiscal 1959.

Air Force planes to be purchased include B-52H heavy jet bombers, more supersonic B-58 medium jet bombers and supporting KC-135 jet tankers, plus additional F-105 supersonic fighter-bombers and C-130 turboprop transports. Navy will buy supersonic A3J attack craft and F8U-2N and F4H all-weather interceptors. Navy will also buy more GV-1 tanker-assault transports and S2F antisubmarine planes.

Army budget calls for a jump of some 35 percent in aircraft procurement fiscal 1960. More orders are slated for Mohawk turboprop observation aircraft, Caribou twin-engine transports, and Iroquois utility helicopters. The first production quantities of the Chinook helicopter are also slated for procurement in fiscal 1961.

Missiles Level Off

In the missile field, total procurement in fiscal 1961 is down $21 million from 1960 estimates. However, the Pentagon disclaims any total reduction in missile spending. Increased research, engineering and test money, plus new programs, will keep overall spending comparable to 1960's figures, the defense budgeters explain. Even though prices have increased one or two percent in 1960, the military argue that more product is being bought for the dollar through state-of-the-art advances. This offsets the price increases, Pentagon spokesmen say.

Missile money for fiscal 1961 will virtually finish the procurement for the Bomarc and Nike-Hercules air-defense missiles. Money will continue to be pumped into the Talos, Terrier and Tartan fleet air-defense missiles, however. "Large numbers" of air-to-air missiles such as the Sparrow, Falcon and Sidewinder will be purchased in 1961. Procurement of the Hound Dog and Quail for use by the B-52 will be "continued at a high level."

Spending on Atlas and Titan ICBMs will continue to take a big bite of the defense dollar. Present programs call for 13 Atlas squadrons of 10 missiles each and 14 Titan squadrons of 10 missiles each. So far, all 13 Atlas squadrons are funded: 10 squadrons are fully

ELECTRONICS IN THE NEW BUDGET

	FISCAL 1960		FISCAL 1961	
	OBLIGATIONS	ESTIMATED EXPENDITURES	OBLIGATIONS	ESTIMATED EXPENDITURES
	(All figures in millions of dollars)			
DEPARTMENT OF DEFENSE				
Aircraft Electronics	$1,485.0	$1,667.5	$1,503.2	$1,506.7
Missile Electronics	1,239.0	1,225.0	1,331.7	1,217.6
Shipborne Electronics	75.0	82.5	87.0	82.2
Communications and Other	1,067.2	920.0	985.5	979.2
Research, Development, Test and Evaluation	1,200.0	1,000.0	1,200.0	1,100.0
DEPARTMENT OF DEFENSE TOTAL	$5,066.2	$4,895.0	$5,107.4	$4,885.7
FEDERAL AVIATION AGENCY				
Air Traffic and other Facilities	$ 88.6	$ 75.0	$ 146.2	$ 105.0
Research and Development	24.3	18.0	32.5	25.0
FAA TOTAL	$ 112.9	$ 93.0	$ 178.7	$ 130.0
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION				
Tracking and other Facilities	$ 22.2	$ 10.9	$ 22.3	$ 17.5
Research and Development	80.0	48.2	138.2	87.5
NASA TOTAL	$ 102.2	$ 59.1	$ 160.5	$ 105.0
POST OFFICE Modernization Program	$ 40.0	$ 40.0	$ 40.0	$ 40.0
NATIONAL BUREAU OF STANDARDS R&D	$ 8.6	$ 8.4	$ 9.8	$ 9.7

The government has no official breakdown for electronics purchases or for electronics research programs. Officials use estimates as to the percentage of a program which involves electronics. For example, the official estimate of the amount of aircraft procurement which represents electronics is 25 percent; since the total allocation for aircraft procurement in fiscal 1961 is $6,027 million, electronics' share comes to $1,506.7 million. Here are the percentage figures used in compiling this table:

DEPARTMENT OF DEFENSE Aircraft, 25 percent; Missiles, 35 percent, Shipborne Electronics, 5 percent; Research, Development, Test and Evaluation, 25 percent; Communications and Others, 50 percent. FAA Air Traffic and Other Facilities, 75 percent; Research and Development, 50 percent. NASA Tracking and Other Facilities, 25 percent; Research and Development, 25 percent. POST OFFICE 50 percent. NATIONAL BUREAU OF STANDARDS 50 percent.

the Line

funded, and items with long lead-times are funded for the others. No new orders will be placed for Thor and Jupiter IRBMs in fiscal 1961.

More Space Research

Money budgeted for military space programs will continue or speed up several satellite projects, including the Midas early warning system, the Samos reconnaissance satellite, the Notus communications satellite and the Transit navigation system. Money to start construction of another BMEWS (ballistic-missile early-warning system) facility in England is also included in the new military budget.

The National Aeronautics & Space Administration's money request jumps from around $500 million for this fiscal year to $802 million for fiscal 1961. This increase is partly the result of including in the NASA budget approximately $140 million for the big million-pound-plus thrust engine Saturn, which the President recently transferred from the Army to the space agency. Actual expenditures for 1961 are expected to climb to around $634 million, compared with $370 million in 1960.

Some $32 million has been budgeted to boost the agency's tracking and data-acquisition network. Included is a special tracking network for the Mercury man-in-space project. Additional electronics money will go into the tracking facilities at missile ranges.

Air Traffic Controls

The Federal Aviation Agency will be coming purse in hand to the electronics industry for such things as air navigation facilities. For instance, $17.7 million is earmarked for Vortac (vhf omnirange with Tacan-compatible distance-measuring equipment); $8.3 million for instrument-landing systems; $37.3 million for long-range radar; $50.4 million for traffic control centers, and $13.3 million for air-traffic communications.

The National Bureau of Standards has budgeted some $7 million for physics and electronics, another $4.2 million for radio propagation.

For more QUALITY

than meets the eye . . .

USE

HICKORY BRAND

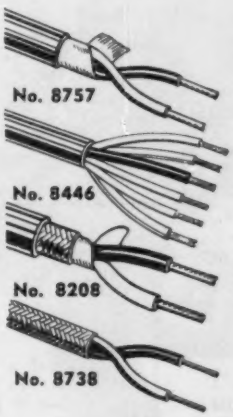
Intercommunicating and Sound System Cables

Manufactured from quality materials, Hickory Brand plastic insulated cables provide long service life and excellent mechanical and electrical characteristics.

Available in shielded and unshielded types for use as inter-connecting cables on electronic equipment, remote control circuits, special microphone circuits, power supply cords and for many other electronic applications.

Quick termination, positive color-coding and small diameters insure maximum economy in all installations.

Representative types:



No. 8757—2 conductors: 20 AWG 7 x 28 Cu. tinned .015" ins. .185" nom. dia.

No. 8446—6 conductors: 4—22 AWG 7 x 30 strand .010" ins.—plus 2 18 AWG 16 x 30 strand .018" ins. .212" nom. dia.

No. 8208—2 conductors: 18 AWG 7 x 27 copper tinned .040" ins. .155" nom. dia.

No. 8738—2 conductors: 22 AWG solid .015" ins. .130" nom. dia.

For more QUALITY than meets the eye . . . decide on Hickory Brand!

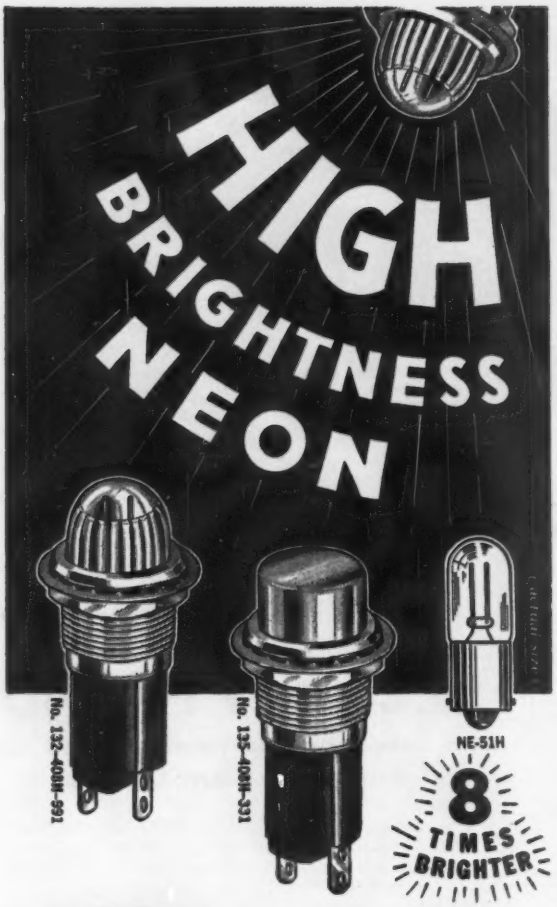
Write for complete information on the full line of

HICKORY BRAND
Electronic Wires and Cables

Manufactured by
SUPERIOR CABLE CORPORATION, Hickory, North Carolina

4421

CIRCLE 33 ON READER SERVICE CARD 33



DIALCO PILOT LIGHTS

with Built-in Resistor

(a patented DIALCO feature)

for the **Neon Glow Lamp NE-51H** (High Brightness)

RUGGED: The NE-51H Neon Glow Lamp is made to resist vibration and is proof against sudden failure. It may be operated at about 3 times the level of current applied to the standard neon lamp, and it will produce 8 times as much light—*with long life!* Requires low power—less than 1 watt on 250 V circuit. Recommended for AC service (may be used on DC circuits above 160 V).

BUILT-IN current-limiting resistor (U.S. Patent No. 2,421,321): For use on 105-125 volt and 210-250 volt circuits. In DIALCO Pilot Lights, the built-in resistor is completely insulated in moulded phenolic and sealed in metal.

COMPACT: Units are available for mounting in 9/16" and 11/16" clearance holes...in a wide choice of lens styles and colors, terminal types, metal finishes, etc. Meet applicable MIL Spec and UL and CSA requirements.

Every assembly is available complete with lamp.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

Ask for Bulletin No. 100 and Catalogue L-161B.

Foremost Manufacturer of Pilot Lights

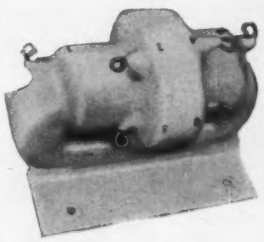
DIALIGHT CORPORATION

58 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600

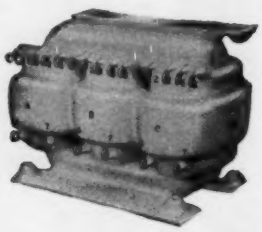
CIRCLE 34 ON READER SERVICE CARD

TRANSFORMERS for APPLICATIONS UP TO 350°C

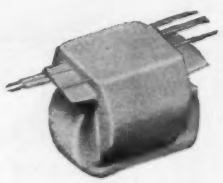
Engineering "know how" and manufacturing facilities are available at Acme Electric to produce prototypes or production runs of transformers that must function with operating temperatures up to 350°C.



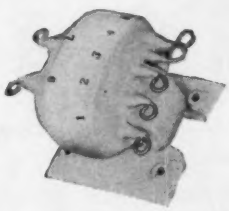
T-36127
Weight: 14 ounces. VA: 47.8
50°C rise, 125°C ambient
12 KV test @ 30,000 feet



T-34671
Weight: 4¼ lbs. VA: 705
165°C rise, 125°C ambient
12 KV test @ 30,000 feet



T-34894
Weight: 260 grams VA: 26.4
30°C rise, 125°C ambient
6.2 KV test @ 30,000 feet



T-36196
Weight: 235 grams. VA: 32
31°C rise, 125°C ambient
5.2 KV test @ 30,000 feet

ACME ELECTRIC CORPORATION

113 WATER STREET • CUBA, NEW YORK

West Coast Plant: 12822 YUKON AVE., HAWTHORNE, CALIF.

PO 3254

Acme ACME Electric TRANSFORMERS

CIRCLE 200 ON READER SERVICE CARD

Umbilical

The MSC-built Umbilical Launching Cable... an example of the product diversity of Missile Systems Corporation. Like all products that bear the MSC label, this system has proven its reliability. Just as it is a life-line to the success of a mission, so also are MSC's contributions material to the future accomplishments of *all* facets of the electronic industry. MSC's variety of products form one continual life-line... feeding an industry which is already changing the life patterns of generations to come.

MSC

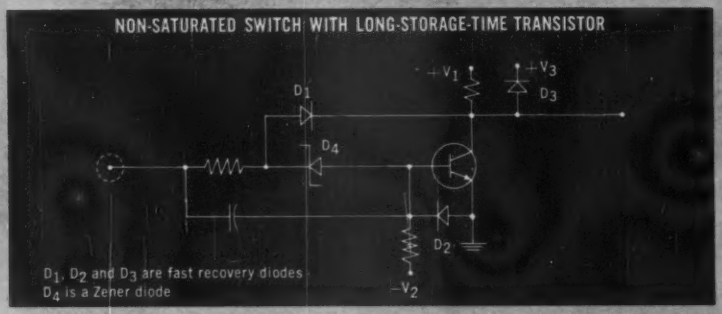
MISSILE SYSTEMS CORP.
11949 VOSE ST., NORTH HOLLYWOOD, CALIF.

Engineering and Manufacturing
Corporation of Texas / subsidiary
Dallas, Texas

CIRCLE 37 ON READER SERVICE CARD

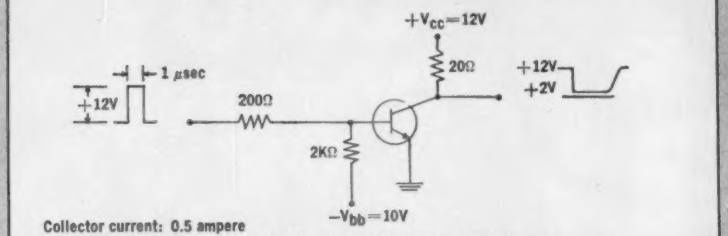
RELIABLE SILICON TRANSISTOR SWITCHING

NON-SATURATED SWITCH WITH LONG-STORAGE-TIME TRANSISTOR



9 COMPONENTS REPLACED BY 4

SATURATED SWITCH WITH 2N1252 TRANSISTOR



Collector current: 0.5 ampere
Typical switching time: t_d=20mμs., t_r=60mμs., t_s=30mμs., t_f=40mμs.

HOW? – By using Fairchild's 2N1252 or 2N1253 **lowstorage** silicon mesa transistors. The guaranteed low storage characteristic permits a simple saturating circuit to achieve switching speeds that previously required complex non-saturating circuits.

WHY? – Improved reliability and reduced cost – one semiconductor instead of five and fewer soldered connections. Power dissipation is only 1/3rd to 1/5th as great, making possible much higher component densities in packaging. Cost and reliability are improved all the way from development through volume production.

WHERE? – Switching circuits in general. The 2N1252 and 2N1253 are ideally suited to high-speed high-current switching applications such as magnetic-core drivers, drum and tape write drivers, high-current pulse generators and clock amplifiers. In addition, the transistors are applicable to medium-speed saturated logic circuits.

FAIRCHILD 2N1252 and 2N1253

Symbol	Characteristic	Rating	Min	Typ	Max	Test Conditions
h_{FE}	D.C. pulse current gain 2N1252		15	35	45	I_C=150mA V_C=10V
	2N1253		30	45	90	
P_C	Total dissipation at 25°C case temperature	2 watts				
$V_{BE\ SAT.}$	Base saturation voltage			0.9V	1.3V	I_C=150mA I_B=15mA
$V_{CE\ SAT.}$	Collector saturation voltage			0.6V	1.5V	I_C=150mA I_B=15mA
h_{fe}	Small signal current gain at f=20mc 2N1252		2	4		I_C=50mA V_C=10V
	2N1253		2.5	5.5		
I_{CBO}	Collector cutoff current			0.1μA	10μA	V_C=20V T=25°C
				100μA	600μA	V_C=20V T=150°C
t_s+t_f	Turn off time			75mμs	150mμs	I_C=150mA I_{B1}=15mA
						I_{B2}=5mA R_L=40Ω
						Pulse width=10ms

For full specifications, write Dept. A-1.

FAIRCHILD SEMICONDUCTOR CORPORATION

545 WHISMAN ROAD • MOUNTAIN VIEW, CALIFORNIA • YORKSHIRE 8-8161 • TWX: MOUNTAIN VIEW CAL 122
New York Area: Pioneer 1-4770 • Syracuse: GRanite 2-3391 • Philadelphia Area: TUrner 6-6623
Washington D.C.: NAtional 8-7770. • Chicago: BRowning 9-5600 • Los Angeles: OLeander 5-6058

New Approaches to Reliability

Military weapon system development is said to stress too much breakthrough research and too many unit cost compromises

CHANGES in government-supported R & D and in contract bidding to increase the reliability of military electronic systems were called for last week at the sixth annual Symposium on Reliability and Quality Control.

J. K. Sprague, president of Sprague Electric Co., said in a keynote address that the government could help attain reliability by fostering sound, long-range research and development programs aimed at systematic upgrading of reliability.

Too much of our R & D effort, he said, is concentrated on breakthrough research. The results frequently bear on specific applications, and do not serve to increase the reliability of standard parts and materials.

He urged the Department of Defense to stress that quality and reliability are the most important ingredients of weapon systems, which in turn precludes "excessive concern with unit cost as a valid criterion in weapons requirements." There must be complete and uniform specifications, he said, without loopholes, so that some individuals cannot make compromises in the interest of lower cost and at the expense of reliability.

He charged that the practices of waiving test requirements and lot-by-lot control procedures for lower cost is "very widespread today."

Would Limit Bidding

Sprague called for "modified" competitive bidding, with suitable restriction on those contracts which require high levels of reliability. He would limit bidding to those manufacturers who have demonstrated their ability to produce to required reliability levels.

The qualified products list should be revised, he said, to be sure that products listed continue to meet requirements. He advocated maximum standardization of high reliability components.

Components have been overlooked in the glamour of many large systems, said banquet speaker Vice Admiral J. T. Hayward, USN, assistant chief of naval operations, in his address on research and development aspects of reliability. Admittedly, he said, it has been easier in the past to obtain money for many large systems but the results have shown "we should have paid more attention to our homework on the components."

In the coming year, he told the group, more emphasis will be placed on reliability in components and on materials used in these components. Components and materials represent the very heart of any reliability program, he said.

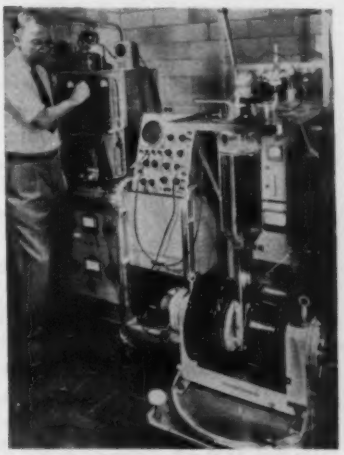
Comments on Sessions

Other symposium papers presented new developments or analysis of problems in various phases of reliability and quality control. Between the sessions, which attracted about 1,100 engineers and scientists from 19 countries, there was considerable discussion of these problems and new devices. Here are two comments:

C. R. Knight, research director, Arinc Research Corp., said progress in reliability at the systems level is disappointingly slow—a lot slower than we are technically capable of moving. "We need a more unified approach both technically and financially," he said. "The trouble lies between the economic and technical points of view in the development stage."

He believes the economic point of view often does not take into consideration the overall cost of the system, including both development and maintenance. Reliability can be traded against time and dollars, he said.

Knight believes some technical people may share the blame in not developing economic arguments with sufficient care. He said the computer, where both in development and maintenance the dollars come out of one pocket, is a good example of an area of unity.



Device materials such as germanium and silicon are subjected to "cold weather" approaching 460 F below zero in this set-up at Sylvania Research Laboratories, Bayside, N. Y.

Technical Approach

A technical approach to reliability came from H. Voegtlen, manager of Applied Research Projects, RCA, Rome, N. Y., and winner of a citation for an outstanding paper at last year's symposium. The problem, he said, in the technical area is that there are no accurate tools for measuring or forecasting total costs of weapons systems for their operational life.

Support costs frequently amount to from 10 to 100 times the procurement cost of equipment during its useful life, he said. Voegtlen suggests that relatively small investments in development of reliability and maintainability prediction techniques that can be applied from design inception through equipment service life will pay off large dividends in reducing support costs.

One session was devoted to a discussion of various programs for the exchange of information between companies in such a way as to further the state-of-the-art in component reliability, reduce costs and shorten delivery delays of equipment.

IMMEDIATE DELIVERY!

ON 3/8" AND 1/2" O.D.

Non-Magnetic

18-8 TYPE 303 STAINLESS

UNIVERSAL JOINTS

Manufacturers of electronic equipment have come to depend on Curtis for precision-made non-magnetic universal joints of 18-8 Type 303 stainless steel, in the sizes most frequently used in the industry. Other sizes are also readily available; also bronze joints.

Curtis joints benefit by a rigid insistence on uncompromising inspection and quality control at every stage of manufacture, insuring minimum backlash.

Curtis torque and load ratings are entirely dependable, since they are based on continuous testing under actual operating conditions.

Not sold through distributors. It will be to your advantage to write or phone (REpublic 7-0281) for free engineering data and price list.

CURTIS TRADE MARK

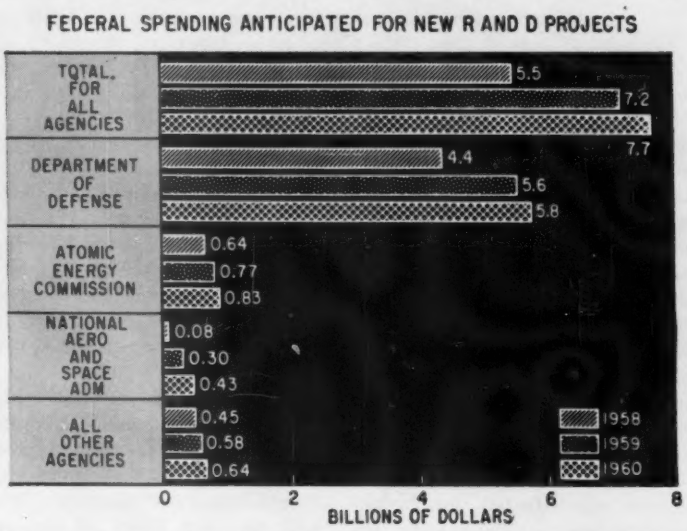
UNIVERSAL JOINT CO., INC.

191 Birnie Avenue, Springfield, Mass.

As near to you as your telephone

A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

R & D to Surpass



Federal spending for research and development will set a new record this year

RESEARCH and development spending by the federal government will hit the highest point in history this year, according to a survey by the National Science Foundation.

What proportion of total R & D spending will go for electronics is not certain, but Washington sources are now framing estimates. (See p 32 for budget details.)

Total outlay for federal R & D spending will be about $15½ billion compared with last year's estimated $14½ billion and 1958's $10½ billion.

Actual contracts for 1960 have been committed or are in negotiation for about $7½ billion. More than an additional $8 billion is earmarked for additional projects.

Lion's share of the now uncommitted funds will be the Defense Department's $5.8 billion for military projects. Last year's total was about $5.6 billion, with $4.4 spent in 1958 (see graph).

It is likely that a good 65 percent of all military R & D will go to "profit organizations" or private industry. Nine percent will probably go to educational institutions, while some 24 percent will be administered within federal defense agencies. Of this 24 percent, a portion of the funds may find their way into private industry through subcontracts.

Contractors to the Atomic Energy Commission, the second largest beneficiary of this year's R & D budget, will see about $830 million spent on new projects. AEC's distribution of funds to industry, government agencies and other organizations will break down in much the same way as DOD's.

National Aeronautics and Space Administration will receive the third largest share of the federal R & D funds. Total estimated spending for the year on new projects will be $430 million. In 1958, NASA's R & D budget was only about $8 million, rising to close to $300 million in 1959. (NASA assumed the activities of the former National Advisory Committee for Aeronautics and combined them with responsibility for civilian studies of outer space.)

FAA Funds Rise

Also increasing is the budget for the Federal Aviation Agency whose estimated R & D obligations rose from $16 million in 1958, to $20 million in 1959 and will hit $49 million this year. (FAA last year took over the research and development programs of the Airways Modernization Board, the Civil Aeronautics Administration and other civilian aviation responsibilities.)

New work planned by federal agencies is divided according to the

$15 Billion

branches of science for budgetary purposes. While the life sciences will get some $550 million for new work in the fields of biology, medicine and agriculture, it is the physical sciences which will gain the greater share. Total spending in the physical science area will come to about $1.1 billion. Of this, $509 million will go for engineering science, $54 million for mathematical studies and $533 million for other areas.

In 1959 the engineering sciences received about $414 million, and in 1958 some $278 million.

Of an Army total of $1,090,900, $141,564 will go for applied research, $20,113 for basic research and $907,301 for development.

Similarly, the Navy will probably disperse some $1,298,226 as follows: $1,113,305 for development, $135,295 for applied research and $49,250 for basic research.

Expectations are that the Air Force will spend a greater amount on R & D than either the Army or the Navy. Of a total of $2,768,538, the Air Force will spend some $1,113,305 for development, $135,295 for applied research and $36,000 for basic research.

Million-Watt Transmitter Set

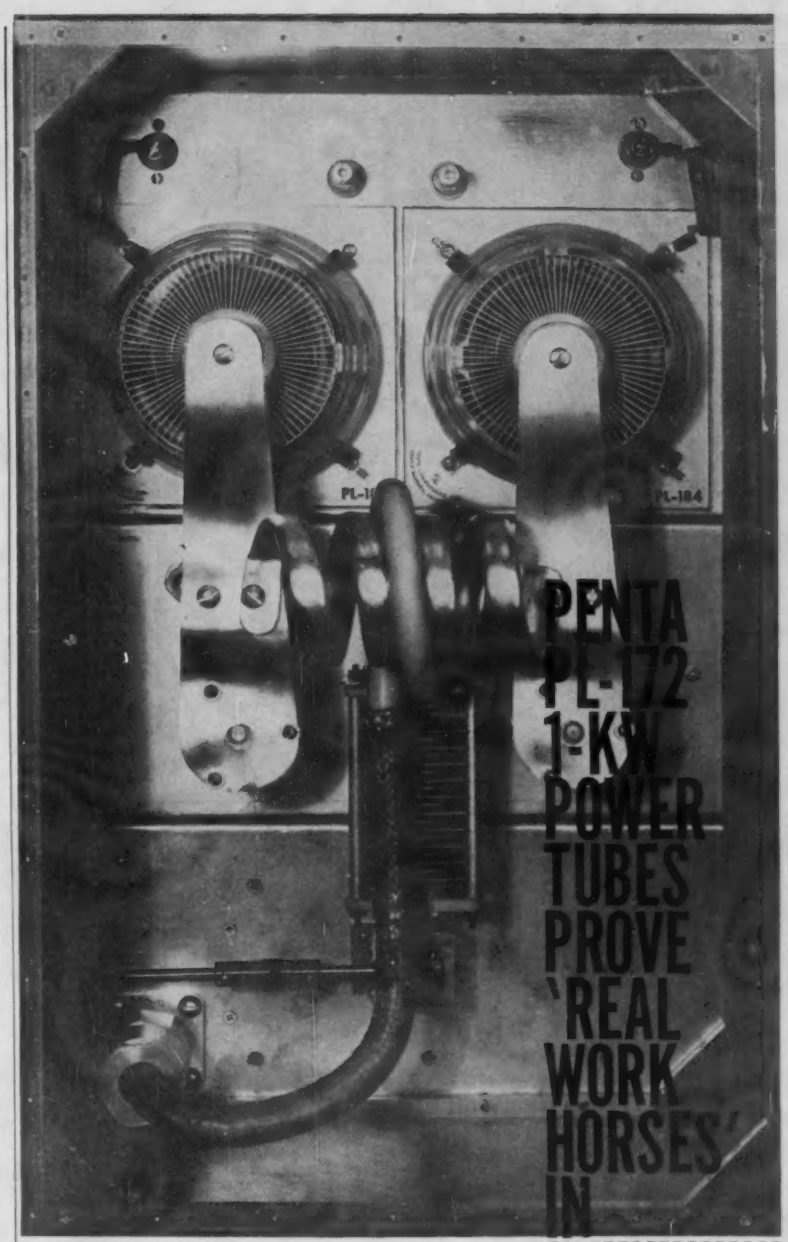
SUPER-POWER transmitter in Cutler, Me., will be completed before the end of this year according to Navy spokesmen.

Output will be more than one million watts with signals beamed largely at undersea missile submarines. Broadcasts will be in the vhf band.

All main towers in one of the two projected arrays have been completed. Each array includes a six-pointed complex of elevated wire panels supported by a central tower 980 ft high.

Antenna efficiency is projected at 70 percent as against 30 percent for any similar station now in use.

The big arrays will be able to detect missile and atomic launchings anywhere in the world by detecting echoes caused by ionized trails.



"We really cut loose with the Penta PL-172's in our meteor scatter system testing, and do they hold up!" says project engineer John Chambers of Hughes Aircraft Communications Division. "We run our Pentas continuously eight hours a day, day after day, at their full 5-kw output. They're real work horses!"

Hughes communications engineers use the PL-172 beam pentodes in the power amplifier section of the exotic 49-mc scatter system transmitter, which utilizes ionized meteor trails in place of the ionosphere for reflection of electromagnetic waves.

Penta PL-172 1-kw power pentodes are available immediately off the shelf. Call or write now.

We'll be glad to send a data sheet on the PL-172, including full ratings, characteristic curves, and information on Class-AB_1 and Class-C operation.

HUGHES

EXOTIC METEOR SCATTER SYSTEM TESTS

PENTA LABORATORIES, INC.
312 N. Nopal St., Santa Barbara, Calif.

CIRCLE 41 ON READER SERVICE CARD

electronics buyers' guide and reference issue
THE ELECTRONICS MAN'S BASIC BUYING BOOK

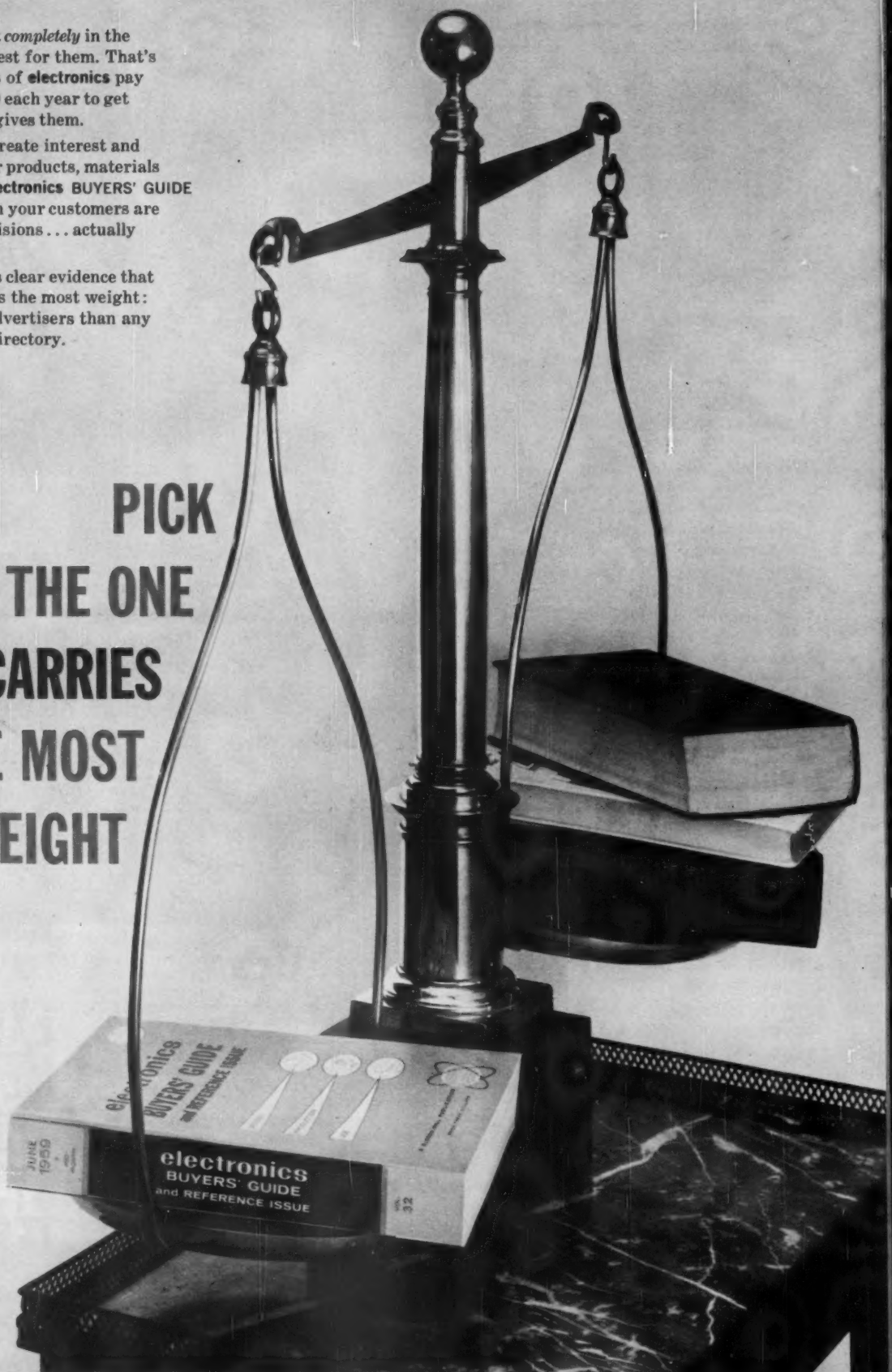
A McGRAW-HILL PUBLICATION
330 West 42nd St., New York 36, N. Y.

People believe most *completely* in the things that work best for them. That's why 52,000 readers of **electronics** pay more than $300,000 each year to get the information it gives them.

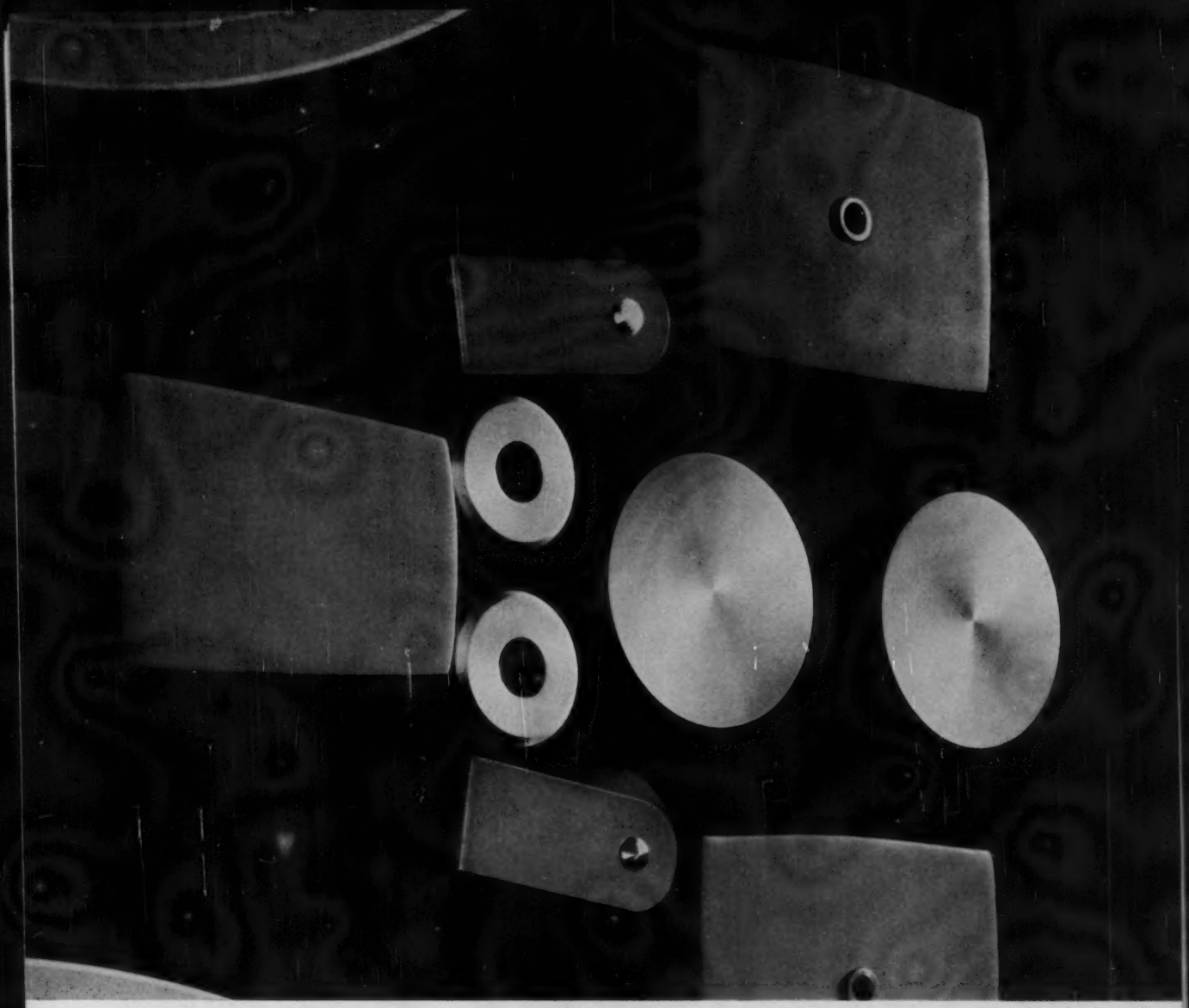
Use **electronics** to create interest and acceptance for your products, materials or services. The **electronics** BUYERS' GUIDE gets you there when your customers are making buying decisions . . . actually sells for you.

Exclusive! There is clear evidence that the "GUIDE" carries the most weight: it has 42% more advertisers than any other electronics directory.

PICK THE ONE THAT CARRIES THE MOST WEIGHT

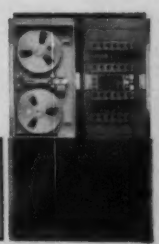


9.53

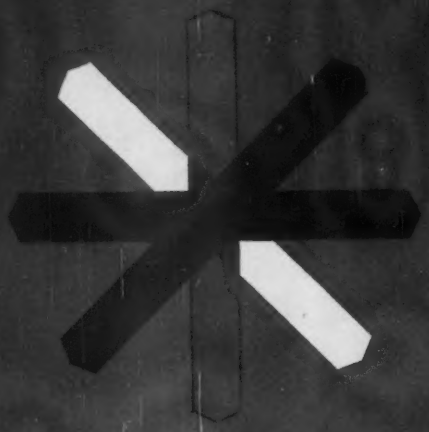


Better machines make good machines obsolete. *Usually*. The remarkable thing about the new Ampex FR-600 is that it doubles the usefulness of every Ampex analog recorder ever built. And it *is* unquestionably a better machine. But it is compatible with earlier models. It actually lets you do things with them you never could before. Like record the same bandwidths at half the usual speed. 100 kc at 30 ips, for instance. Twice as many minutes on the same reel of tape therefore. Pretty important in airborne use of the Ampex AR-200, or mobile use of Model 800's. Even important in lab installations using FR-100's or 1100's. Doubled recording time is always useful. Sometimes indispensable. It's possible because bandwidth is determined by the reproduce head. If your data will be reproduced on an FR-600, you simply drop the bias current on earlier machines to 9 milliamperes. A 5-minute screwdriver adjustment. Then you record the same bandwidth at half the speed and get twice the recording time. A good reason for getting the full FR-600 story. AMPEX DATA PRODUCTS CO., 934 Charter St., Redwood City, Calif.

This machine doubles the value of every Ampex analog recorder



FR 600 AMPEX



Lockheed Missiles and Space Division

invites your inquiry into these

UNUSUAL RESEARCH AND DEVELOPMENT OPPORTUNITIES

Important career positions are available at Lockheed Missiles and Space Division at its new facilities on the beautiful San Francisco Peninsula — one of the choicest living areas in the nation. Headquarters for the Division are at Sunnyvale, California, with Research and Development Facilities located in the Stanford Industrial Park in nearby Palo Alto.

The Division is widely diversified—having complete capability in more than 40 areas of science and technology, from concept to operation. Areas of work include: metallurgy; sonics; reconnaissance; computer design and development; propulsion and exotic fuels; space physics; hydrodynamics; the flight sciences; space medicine; manned space vehicles; telemetry; electronics; applied mathematics; operations research and analysis; space communications; reentry; design; and test, both environmental and flight.

Equipment and facilities are completely modern and include one of the largest computer centers in the world.

The Division is systems manager for several major, long-range projects and its research and development programs reach far into the future. It is a rewarding future with a company that has an outstanding record of leadership and progress.

Unusual opportunities exist for experienced engineers and scientists to contribute to the solution of new problems in the areas listed on the next page. If you are experienced in these areas, or have background in related fields, we invite your inquiry. Please write: Research and Development Staff, Dept. A-22, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense clearance required.

AERO AND FLIGHT DYNAMICS AND PERFORMANCE

Advanced degree preferred with background in one or more of the following areas: flight test analysis of reentry trajectories and/or systems evaluation; flight test analysis of trajectories and separation evaluation; theory of subsonic and hypersonic aerodynamics; underwater stability and control hydrodynamics; aerodynamic preliminary design studies; research in gas dynamics studies of thrust vector controls, stage separation, propulsion systems analysis, and rocket nozzle design; or wind tunnel studies and testing.

ANALOG COMPUTING

Advanced degree required with real time experience with analog computers. For the solution of problems in flight controls; guidance; aero and thermo dynamics; dynamic analysis and process controls.

ANTENNA DESIGN

Advanced degree in E.E. preferred with background of several years' experience in antenna design for space vehicles.

CHEMISTRY

Ph.D. preferred, advanced degree required, with strong research background for development work in fuel cells; batteries; the direct conversion of electrochemical energy; electrode kinetics; catalysis; photochemistry; thin film; and solid state. Work concerns both military and commercial applications.

Advanced degree required, Ph.D. preferred with background in either physical-organic chemistry; inorganic chemistry; analytical chemistry; or electrochemistry for research and development work in such areas as: instrumental analytical techniques including infrared, ultraviolet and mass spectroscopy; gas solid reaction kinetics; microchemical analysis techniques; surface treatment of metals and surface reaction kinetics; molecular resistance of substances to various environments including formulation of elastomers; or reinforced plastics.

INFRARED

Advanced degree in E.E. or physics preferred but not required, with experience in infrared systems research and development, or electrical engineers with background in electronics information theory; servomechanisms; specialized circuitry, as in low-level voltage circuits, or physicists with background in optics or semi-conductors. For work in infrared physics research; advanced systems development; or physical measurements in infrared.

TELECOMMUNICATIONS

Degree in E.E. or communications with background in design of UHF, VHF and RF transmitters; telemetry systems and components; circuit design or logical design components.

LOGICAL DESIGN

Background of graduate work in E.E. or math., with interest in advanced areas of computer research in such efforts as: pattern recognition; automata studies; logical design and switching theory; information retrieval; and behavior patterns of artificial neurons patterned closely after those of the human brain.

MECHANICAL DESIGN

Advanced degree in M.E. preferred with background of mechanisms and small structures desirable. For research in experimental design and the development of a variety of research test models.

Advanced degree in M.E. preferred with experience in the design of aero and thermodynamic missile scale models including previous work in wind tunnel model design and test. Shop liaison experience desirable.

METALLURGY

Advanced degree preferred for basic and applied research in one or more of the following areas: metallurgical behavior and mechanisms concerning high temperature and advanced missile materials with interest in metal physics; deformation and fracture; phase equilibria; transformations; or diffusion. Also, to conduct basic and applied studies in refractory metals; dispersed phase systems; fiber metallurgy; ceramics and thermal protective materials systems. Also, for X-ray and electron diffraction research and studies in single crystals; point defects; parameter measurements; pole figure determinations.

MICROWAVE

Experience required in MASER amplifiers and variable reactance parametric devices, for experimental research in microwave.

ORDNANCE

Degree in E.E. or M.E. required and several years' experience in developmental testing of ordnance and pyrotechnic devices, preferably in the missile field, with complete familiarity with high speed oscillography; pin techniques; pulse circuitry techniques; high speed photography; and instrumentation methods for recording pressure; shock; velocity and temperature for the development of ordnance equipment for missiles.

SOLID STATE DEVICES

Advanced degree required and Ph.D. preferred in E.E., physics or chemistry and evidence of creative, original work through published articles, patents or superior Ph.D. theses for research work in one or more of the following: thermoelectric; photovoltaic; lumistor; ferrite; logic component; sensor; thermistor; or cryogenic devices. Also, materials analysis and evaluation; processing techniques design and development of novel electronics devices and components; circuit analysis; circuit topology; or microminiaturization.

Lockheed / MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER Program and the MIDAS and SAMOS Satellites; Air Force X-7; and Army KINGFISHER

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIF. • CAPE CANAVERAL, FLA. • ALAMOGORDO, N.M. • HAWAII

This is NASA's

Inflatable Communications Satellite

. . . as tall as a 10-story building

This shimmering sphere of aluminized plastic, merely one half of a thousandth of an inch thick, is 100 feet in diameter, yet it weighs only 150 pounds. The satellite will be several times brighter than the Pole star and will be plainly visible with the naked eye while orbiting the earth every 118 minutes at an altitude of 1,000 miles.

The NASA inflatable satellite is a significant step in the development of advanced global communications. The satellite will reflect radio and radar signals from powerful earth-bound transmitters for investigation of forward scattering techniques of communications and propagation. NASA has invited scientists around the world to participate in this project.

This endeavor—only one of many now in advanced stages of fruition . . . is indicative of the calibre of NASA projects, personnel and resources.

If you are a scientist or engineer and would like to become associated with NASA, address your inquiry to the Personnel Director of any of the following NASA research centers:

Langley Research Center,
Hampton, Va.

Ames Research Center,
Mountain View, Calif.

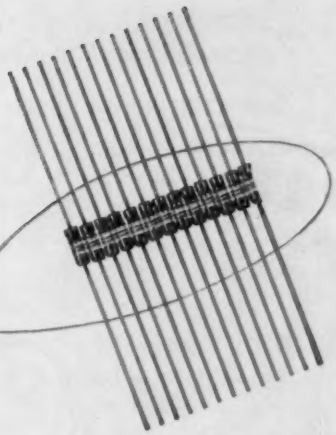
Lewis Research Center,
Cleveland 35, Ohio

Flight Research Center,
Edwards, Calif.

Goddard Space Flight Center,
Washington 25, D. C.

NASA National Aeronautics and Space Administration

Now available in commercial quantities!



Sylvania D-1820 germanium High-Speed Switching Diode

4 mμSECS

GUARANTEED MAXIMUM RECOVERY TIME!

SYLVANIA D-1820 is the forerunner of an outstanding family of diodes, designed, produced and controlled specifically for logic circuitry. The cost of this new SYLVANIA diode is low enough to make it especially attractive for use in quantity-produced electronic computers. SYLVANIA D-1820, and the circuits designed around this diode, feature:

high-speed operation – with recommended circuits, all units are guaranteed to provide a maximum recovery time of 4 millimicroseconds. However, recovery times of 2.5 millimicroseconds are typical.

long-life performance – proved in 1000-hours operating and 7000-hours storage life tests.

high reliability – basic point-contact structure has been field-proved for more than a decade. Withstands environmental conditions of shock and vibration.

exceptional uniformity of electrical characteristics—assures complete interchangeability within the type—result of modern automated-production techniques employed in the manufacture of SYLVANIA D-1820.

economy – SYLVANIA pioneered the field of germanium point-contact diode manufacture, has "know-how" of superior-quality, large-quantity economical production. SYLVANIA is able to pass these savings on to you.

simplicity—diode-logic circuitry is relatively uncomplicated, requires few components. It reduces computer construction costs. It adds to equipment reliability.

compactness—SYLVANIA D-1820 "package" is miniature all-glass.

availability—units can be supplied immediately through your local Sylvania Semiconductor Distributor or through your local Sylvania Field Office.

Complete sales information on quantity prices, delivery and sampling for your own evaluation is available from your local Sylvania Semiconductor Distributor or Field Office. For engineering data sheets on the new Sylvania D-1820 High-Speed Switching Diode or on any Sylvania Semiconductor Device, write Sylvania Semiconductor Division, Dept. **22-1,** Woburn, Mass.

ELECTRICAL CHARACTERISTICS— SYLVANIA D-1820	
Absolute Maximum Ratings*	**Typical Operating Conditions***
Fwd. Volt .....1.3 V†	Fwd. Volt.....0.9 V
Fwd. Curr. .....30 mA	Fwd. Curr. .....2.0 μA
Back Volt .....20 V	Rev. Recovery.....2.5 mμs
Pwr. Diss. .....80 mW	

†at 10 mA *at 20° C.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

CIRCLE 47 ON READER SERVICE CARD 47

BIRD

"Termaline" 50 ohm Coaxial Line LOAD RESISTORS

82-A
(500 Watts)

SERIES 80-82

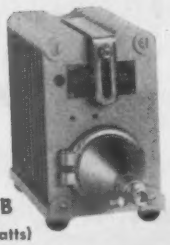
- Frequency Range: DC to 4000 mc
- Power Range: 20 to 2500 Watts
- Non-Radiating
- VSWR: 1.1 max. to 1000 mc.

APPLICATIONS

Accurate termination for 50-ohm coaxial systems, as dummy antennas, during adjustment, alignment and testing.

80A
(20 Watts Max.)

81
(50 Watts)



81-B
(80 Watts)

SPECIFICATIONS

MODEL	MAXIMUM POWER (In Still Air)	FREQUENCY RANGE	MAX. VSWR	INPUT CONNECTOR	WEIGHT	MAXIMUM DIMENSIONS HEIGHT	LENGTH	WIDTH
80-A	20 W	0-1000 mc	1.1	"N" Female	2 lbs.	4 1/4"	4 5/16"	1 1/2"
81	50 W	0-4 kmc	1.2	"N" Female	4 lbs.	4 1/2"	9 3/4"	2 31/32"
81-B	80 W	0-4 kmc	1.2	"N" Female	4 lbs.	6 11/32"	9 3/8"	3 15/16"
82-A	500 W	0-3.3 kmc	1.2	Coplanar Adapter to UG-21 B/U Supplied. RG-17, RG-19 cable assemblies available.	17 lbs.	8 7/16"	18 1/2"	5 15/16"
82-AU	500 W	0-3.3 kmc	1.2	LC Jack mates with UG-154/U plug on RG-17/U cable.	17 lbs.	8 7/16"	19 1/8"	5 15/16"
82-C	2500 W Water cooled	0-3.3 kmc	1.2	Coplanar Adapter to UG-21 B/U Supplied. RG-17, RG-19 cable assemblies available.	26 lbs.	8 7/16"	20 13/16"	5 15/16"

OTHER BIRD PRODUCTS

"Thruline" Directional RF Wattmeters

Coaxial RF Filters

Coaxial RF Switches

"Termaline" RF Absorption Wattmeters

BIRD ELECTRONIC CORP.
CHurchill 8-1200 (Cleveland)
30303 Aurora Road, Solon, Ohio
Western Representative:
VAN GROOS COMPANY, Woodland Hills, Calif.

MEETINGS AHEAD

Jan. 31-Feb. 5: Winter General Meeting, AIEE, Statler Hilton Hotel, New York City.

Feb. 1-4: Instrument - Automation Conf. and Exhibit, ISA, Sam Houston Coliseum, Houston.

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 10-12: Solid-State Circuits Conf., AIEE, IRE, Univ. of Penn., Hotel Sheraton, Philadelphia.

Feb. 10-12: Cleveland Electronics Conf., ISA, IRE, AIEE, CPS, CIT and WRU, Cleveland Eng. & Scientific Center, Cleveland, Ohio.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 16-18: Nondestructive Testing of Aircraft & Missile Components, Southwest Research Institute, Hilton Hotel, San Antonio, Texas.

Feb. 19-23: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Feb. 25-26: Scintillation Counter Symposium, AIEE, AEC, IRE, NBS, Hotel Shoreham, Wash., D. C.

Mar. 17-18: Synchro Design and Testing Symposium, Bureau of Naval Weapons, Dept. of Navy, Dept. of Commerce Auditorium, Wash., D. C.

Mar. 21-24: Institute of Radio Engineers, Annual A. & M. College of seum & Waldorf-Astoria Hotel, N. Y. C.

Apr. 3-8: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

Apr. 11-13: Protective Relay Engineers, Annual, A. & M. College of Texas, College Station, Texas.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Ambassador Hotel & Memorial Sports Arena, Los Angeles.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 86.

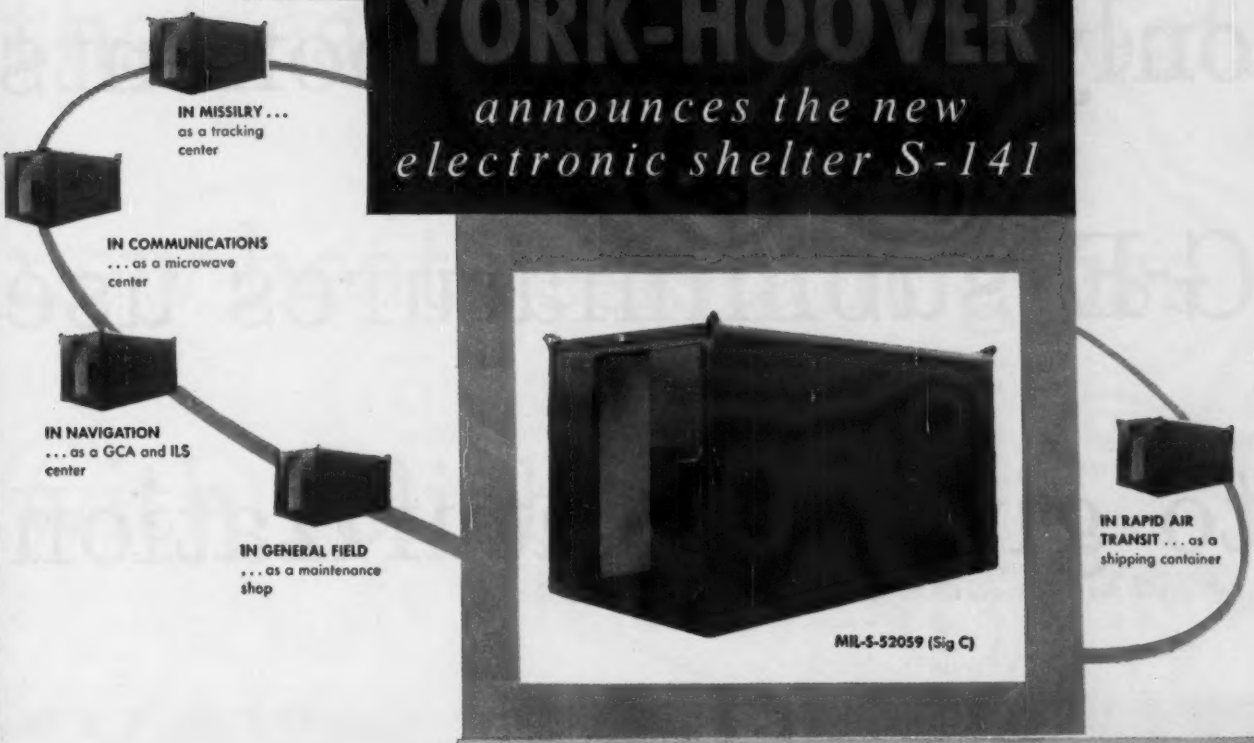
YORK-HOOVER GUARANTEE

The York-Hoover Body Division occupies 350,000 square feet of modern manufacturing facilities. Highly skilled engineers, metal workers, welders and finishers take traditional Pennsylvania Dutch pride in producing this top quality Shelter S-141.

This is your guarantee, backed by 67 years of creative engineering and production "know how."

YORK-HOOVER

announces the new electronic shelter S-141



IN MISSILRY . . . as a tracking center

IN COMMUNICATIONS . . . as a microwave center

IN NAVIGATION . . . as a GCA and ILS center

IN GENERAL FIELD . . . as a maintenance shop

IN RAPID AIR TRANSIT . . . as a shipping container

MIL-S-52059 (Sig C)

EXCLUSIVE FEATURES

ALL WELDED CONSTRUCTION—Inert arc welded aluminum frame resistance welded to the outer skin results in the most rugged and reliable semi-monocoque construction.

SQUARE INSIDE CORNERS—Maximum internal space utilization is achieved; simplified corner installation of ducting, raceways and equipments is permitted.

LIGHTWEIGHT CONSTRUCTION—The unique combination of high strength to weight ratio foams results in the lightest weight sandwich panel construction consistent with military specifications.

REPLACEABLE SKIDS—Designed to permit easy replacement of skids.

FLEXIBLE DESIGN WITH MINIMUM COST—The York-Hoover shelter design lends itself to maximum individual custom requirements, such as, access openings, internal reinforcements, overall dimensions and similar modifications.

TESTED AND APPROVED—The York-Hoover S-141 Shelter has been tested and complies with U. S. Army Signal Corps specification.

PARTIAL LIST OF CUSTOMERS

U. S. Army Signal Corps
U. S. Marine Corps
American Electronics Laboratories, Inc.
Motorola, Inc.
Philco Corporation

York-Hoover Loading Device permits simple and reliable loading of shelters on military type trucks in all terrains.

YORK PENNA.

Creative Engineering for Industrial and Military Products Since 1892

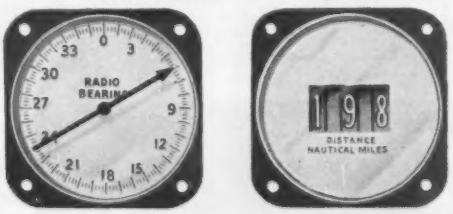
Write for Bulletin No. 949

Miniaturization means only active components G-E subminiatures use to give miniaturization

HOFFMAN TACAN: MEETS 780% - HIGHER AGREE* SPEC!

*Advisory Group on Reliability of Electronic Equipment, which has set a new standard of 150 hours mean-time-to-failure for TACAN.

General Electric subminiature tubes with heat-resistant glass have played a key role in advancing the reliability of Hoffman Electronics Corporation's new ARN-21C to nine times that of older TACAN equipment.



Compactness is a feature...transmitter, receiver, and electronic computer functions all are grouped in one "black box" that measures only 8 by 11 by 17 inches. Heat build-up necessarily is substantial.

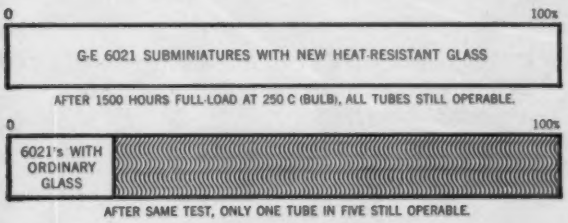
In General Electric subminiature tubes, Hoffman found the answers to their pressing need for tubes that would stand up to heat *with no sacrifice in reliability.* 28 G-E subminiatures are used in the ARN-21C.

heat. Tubes are the that can withstand heat. new heat-resistant glass with reliability.

ACTUAL SIZE

WHAT TESTS SHOW

Life tests of G-E subminiatures with new heat-resistant glass prove that high-temperature operation has no adverse effect on reliability. Check the total absence of failures with G-E type 6021 after 1500 hours at 250 C, against the high failure rate of ordinary 6021's under the same conditions!


0
100%
G-E 6021 SUBMINIATURES WITH NEW HEAT-RESISTANT GLASS
AFTER 1500 HOURS FULL-LOAD AT 250 C (BULB), ALL TUBES STILL OPERABLE.
0
100%
6021's WITH ORDINARY GLASS
AFTER SAME TEST, ONLY ONE TUBE IN FIVE STILL OPERABLE.

Type 6021 is a key tube in Hoffman's TACAN circuit. Glass electrolysis—cause of 90% of tube failures at high temperatures—has virtually been eliminated by General Electric in the 6021 and other subminiature receiving tubes.

SPECIFY FOR RELIABILITY

Small...smaller...smallest! The trend in electronic equipment is *down* in size, *up* in reliability requirement. Heat is the gremlin ready to play hob with your circuitry, unless you take steps to specify devices that are completely dependable when temperatures rise sharply.

General Electric subminiature tubes are proved performers at high temperatures. And their small dimensions give you the extra compactness you need to meet tight equipment size limitations. Telephone your nearest General Electric Receiving Tube Department office below!

NEW YORK	CHICAGO	LOS ANGELES
Wisconsin 7-4065,6,7,8	SPring 7-1600	GRanite 9-7765

Progress Is Our Most Important Product

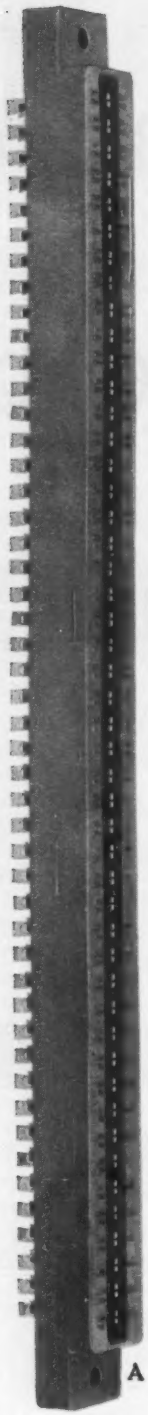
GENERAL ELECTRIC

431-201

Continental Connector Announces

NEW PRINTED CIRCUIT CONNECTORS

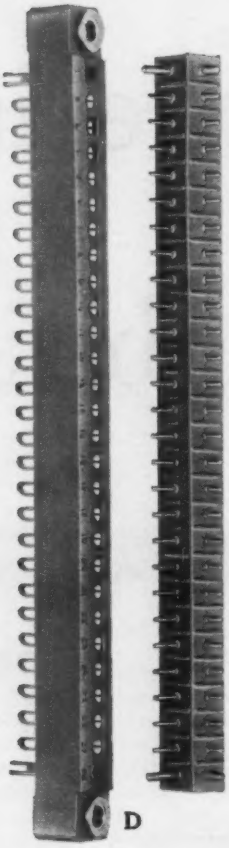
4 New Designs for Computer Applications



A

B

C



D

A—48-contact printed circuit connector for 1/16-inch printed circuit board; dual row, up to 96 connections. "Bellowform" contacts.

B—Test Point Connector. 28 closed entry contacts, threaded mounting inserts molded into body. For dip soldering to printed circuit board.

C—36-contact printed circuit connector for 1/16-inch printed circuit board, featuring new "Bellowform" contacts.

D—Right angle plug and socket for dip soldering to printed circuit board; floating mounting bushings, 28 contacts.

Continental Connectors

Proven reliability . . . high precision . . . choice of molding compounds. Write for details on complete line of printed circuit connectors to Electronics Division, DeJUR-AMSCO CORPORATION, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agents).

Official U.S. Naval Observatory Photo

Leaders in Missiles / Space Technology —
BOOSTER SYSTEMS, ELECTRONICS, GROUND SUPPORT EQUIPMENT, AND NUCLEONICS.

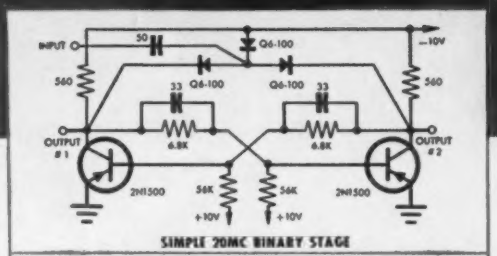
MARTIN

PHILCO ANNOUNCES

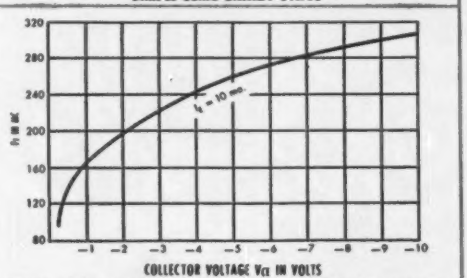
NEW ULTRA HIGH-SPEED SWITCHING TRANSISTOR

WITH CADMIUM ELECTRODES

...IN TO-9 PACKAGE

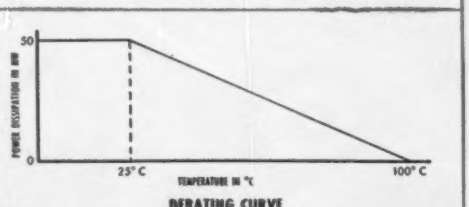


SIMPLE 20MC BINARY STAGE



COLLECTOR VOLTAGE V_{CE} IN VOLTS

TYPICAL GAIN-BANDWIDTH PRODUCT, f_T VS. COLLECTOR VOLTAGE



DERATING CURVE

*MADT . . . TRADEMARK PHILCO CORPORATION for Micro Alloy Diffused-base Transistor.

New MADT* 2N1500 Provides Increased Power Dissipation

Here is another Philco "break-through" in the design and manufacture of high frequency, ultra high-speed switching transistors! This new Micro Alloy Diffused-base Transistor (MADT*) uses cadmium electrodes in place of indium. The higher thermal conductivity of cadmium insures cooler-running junctions for any given power dissipation and provides an extra margin of safety as added assurance of reliable performance.

The new 2N1500 offers the designer these important advantages:

- 100° C maximum junction temperature
- low collector capacitance
- low saturation voltage
- high Beta and excellent Beta linearity with temperature and current
- low hole storage time (Typical: 7 mμsec)

In electrical characteristics, the 2N1500 is similar to 2N501, which has been thoroughly field-proven in many military and industrial computer applications. It is manufactured on Philco's exclusive fully-automated production lines to the highest standards of uniformity. For complete specifications and applications data, write Dept. **E-160.**

Max. Ratings		Typical Parameters				
T_{STG} ° C	V_{CB} volts	t_r mμsec	t_s mμsec	t_f mμsec	h_{FE}	$V_{CE}(SAT)$ volts
100	−15	12	7	4	35	−0.1

AVAILABLE IN PRODUCTION QUANTITIES . . . and in quantities 1-99 from your Philco Industrial Semiconductor Distributor.

PHILCO®

LANSDALE DIVISION / LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

electronics

JANUARY 29, 1960

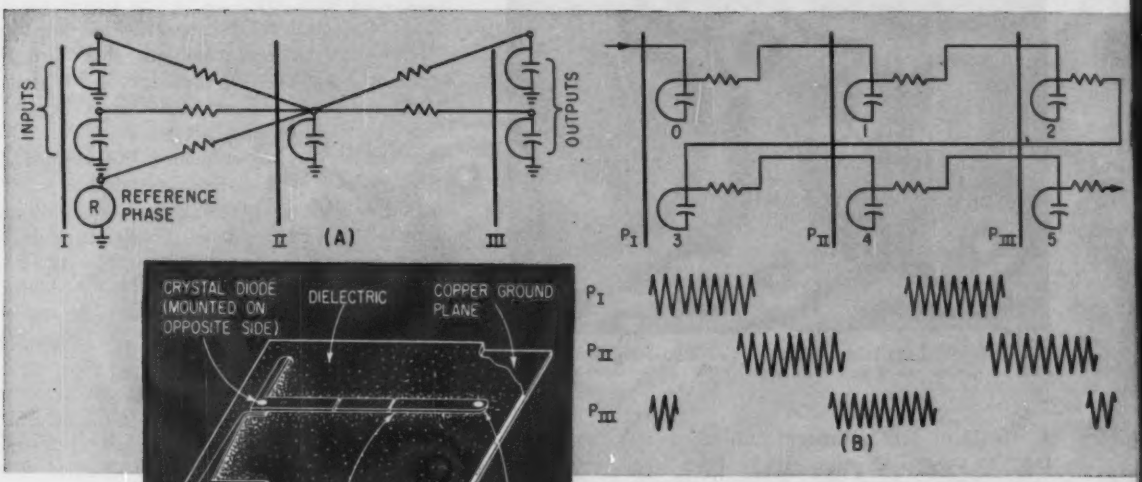


FIG. 1—Generalized PLO logic circuit (A) can be extended to shift register with three-phase pump system (B)

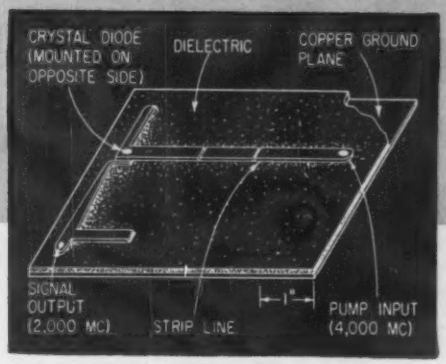


FIG. 2—Microwave subharmonic phase-locked oscillator has 2 kmc quarter-wave resonator with diode in shunt, 4 kmc resonator bar isolating pump and oscillating circuit

Computers Head for 1,000-Mc Operation

Phase-locked oscillators, tunnel diodes and crossed film cryotrons rate high interest as computer elements at Eastern Joint Computer Conference

By **THOMAS MAGUIRE,** New England Editor

COMPUTERS INCORPORATING self-organizing techniques, human-like language and speech recognition, simplified input-output, and vastly improved optical displays, will reach the laboratory stage in 10 years.[1]

They will be microminiaturized special purpose systems for economical on-line real-time use. Their design will require batch-bulk processing, automated logical synthesis and equation-controlled manufacturing. Service will be accomplished by replacing the whole computer.

CHARACTERISTICS—Devices, packages and interconnection will be inseparably merged in the new computers. Major system functions will be produced from bulk materials in computer-controlled, continuous manufacturing processes. Miniaturization will allow vast amounts of available electronic storage and this will drastically alter programming methods.

The path from present-day to future systems will be cleared principally by increased logical capabilities, improved input-output methods, more speed, advances in the art of interconnection as well as active devices, and vast amounts of storage. (See ELECTRONICS, p 77, Nov. 20, 1959.) It is estimated that one-million-bit storage will be needed.

Two uses—now embryonic—offer particularly expansive vistas for computer applications in the future, Eastern Joint Computer Conference Chairman Frank

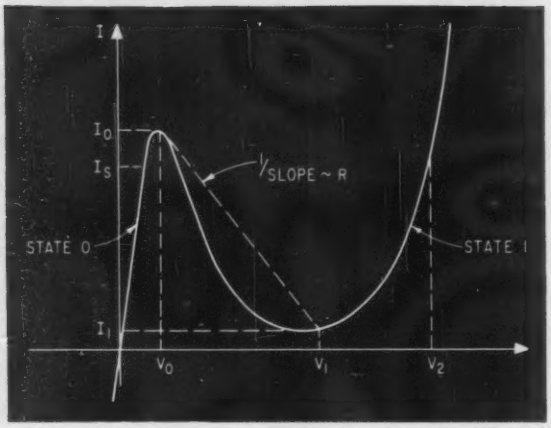


FIG. 3—Tunnel diode characteristic has two distinct regions that are used to denote the 0 and 1 states

E. Heart of MIT's Lincoln Lab points out. The first may be tagged the library problem: efficient storage and retrieval of information, new ways to tap the experience of the past, to connect pertinent researchers to pertinent research—in science, medicine, law and virtually every field of human interest. The second is in the study of the characteristics of biological systems, a field which will generate an invaluable feedback for further computer advances and an approach to artificial intelligence.

HEADING FOR 1,000 MC — Two types of two-terminal semiconductor device, the variable capacitance diode and the tunnel diode, in combination with microwave coupling techniques, give promise of 1,000-mc computers.[2] Both devices provide amplification of binary signals by mechanisms depending on negative resistance and have speed limitations two magnitudes higher than transistors.

Variable capacitance diodes in parametric subharmonic phase-locked oscillators have permitted pumping up to 10 kmc and designing of 4 kmc-pumped, 100-mc logical circuits. Diodes of an order of magnitude higher than conventional types have been developed, with a cutoff frequency of 150 kmc and a high variation of capacitance with voltage.

When a circuit composed of fixed inductance and a capacitance whose value depends on the voltage across it (that is, a junction diode), is excited by a frequency $2f$, approximately twice the resonant frequency of the circuit, oscillations of frequency f can be sustained in either of two opposite phases which can be used to denote 0 and 1. The phase-locked oscillator (PLO) therefore constitutes a storage cell. Oscillations will build up in the phase closest to the phase of a small locking signal which is thus amplified.

Logic can be performed, as shown in Fig. 1, by arraying the PLO's in three groups, which are separately activated. Every PLO is loosely coupled to PLO's in other groups through couplings which determine the task to be performed. Clocking of the groups in succession with some overlap causes information to flow in a given direction despite the bilateral character of the PLO. A PLO will start at the phase determined by the phase of the majority of oscillating PLO's to which it is coupled. The majority decision can be reduced to AND or OR decisions by the use of a reference signal. Negation is obtained by phase inversion.

To obtain 1,000-mc information rates, pump frequencies of about 30 kmc are required. An experimental program ultimately aimed at frequencies of this order resulted in the PLO illustrated in Fig. 2. This device has a broad operating range, efficiencies of a few percent and required pump power levels of about 100 mw. Gold-bonded diodes in series give good results.

Special germanium tunnel diodes have been developed for computer use, with switching times of less than one millimicrosecond. In tunnel diode computers, logic is performed with pulse signals. Two distinct regions of the current-voltage characteristic on either side of the negative region are used to denote 0 and 1, as shown in Fig. 3. Gain is obtained through a triggering action: a large change in output current can be caused by a small input current driving the operating point over the maximum of the characteristic. Practical nearness of biasing to maximum permits logic gains of six. Switching is accomplished by interconnecting simple elements, each made of one or two tunnel diodes and serving as a bit-store, amplifier and threshold majority gate. The single port of each element is connected to a number of inputs and outputs and to clock sources. Three types of element are shown in Fig. 4.

Random access memories can be made using arrays of tunnel diodes. Each bit is stored by a current-driven, bistable tunnel diode. Rows and columns are resistively coupled to the diodes. Selective write-in and read-out is possible either by bit or word addressing because the extrema of the diode characteristic are sufficiently sharp and uniform. Read-out signals

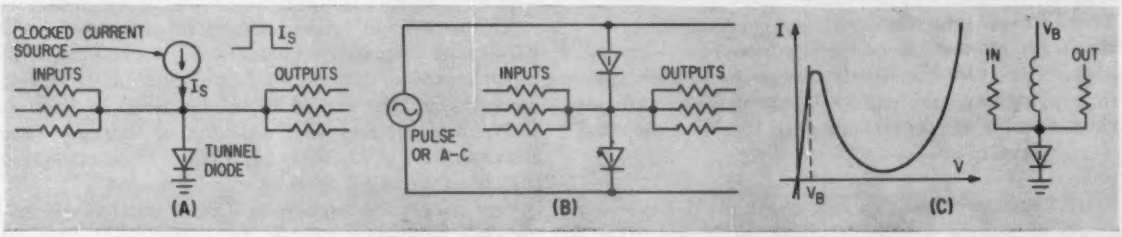


FIG. 4—Tunnel diode logic elements can be of the single bistable type (A), the symmetric bistable type (B) and the monostable type (C)

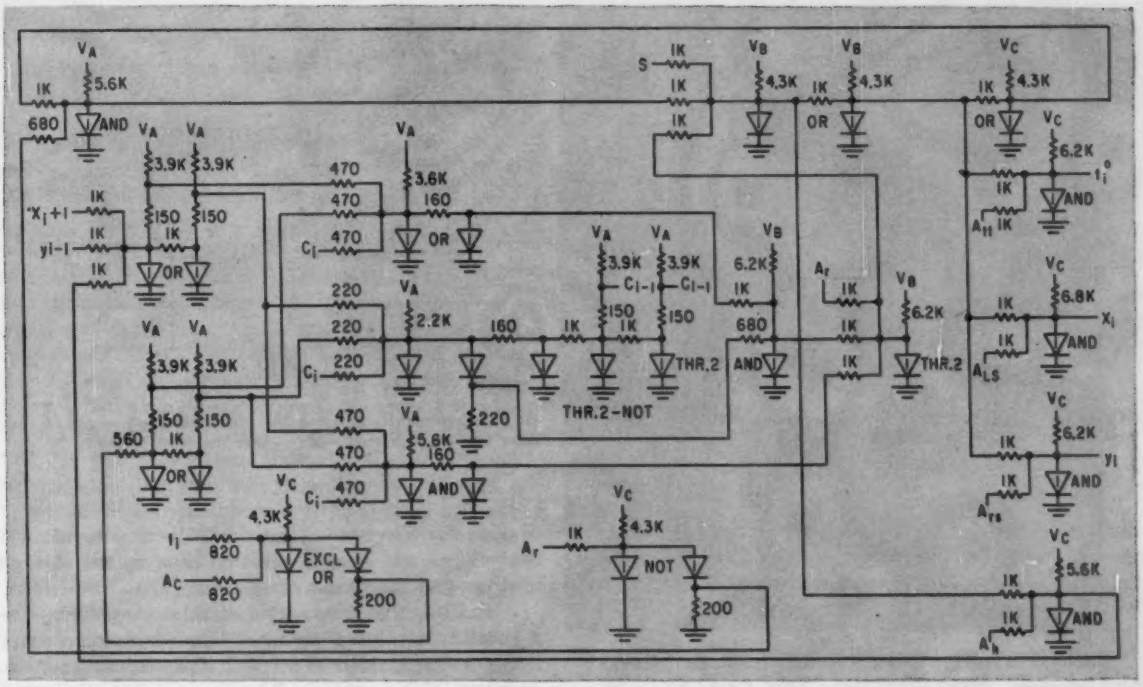


FIG. 5—Arithmetic cell uses 27 tunnel diodes, is powered from a transistorized, three-phase pulse supply

can be detected directly or through inductive pickup of selectively induced oscillations. Drivers for tunnel memory arrays require considerable power which may be switched at sufficient speed by transistors or transistor-tunnel diode combinations. Tunnel diode memories offer promise of 10-millimicrosecond access times.

TUNNEL DIODE AS COMPUTER COMPONENT—Preliminary tests confirm the very high-speed operation capability of the tunnel diode.[8]

Experimental circuits include: single-ended threshold gate consisting of a single tunnel diode powered by a pulse current-source; balanced or symmetrical threshold gate, with its trigger sensitivity independent of power supply variations; an inverter configuration consisting of two tunnel diodes and a resistor powered by the pulse current source; EXCLUSIVE-OR circuit created by extending the principles of the basic inverter configuration to yield a circuit with more than two operating points; a circuit to realize the SUM output of a full adder, using three tunnel diodes and a resistor.

A three-phase, pulse-overlap system is found to be compatible with dynamic storage—circulation of the stored bit around a closed loop. A given gate or group of gates is powered by one phase, drives other circuits powered by the next phase and is driven by still other circuits powered by the previous phase. The excitation pulses overlap in time such that information propagates between two stages during the period when both are energized simultaneously.

Using the pulse supply scheme, three gate circuits, each powered by a different phase, are arranged in a closed loop. The circuit has built-in amplification, reshaping and clocking. Three dynamic storage circuits are possible—a flip-flop, a binary counter and a shift register stage.

Fig. 5 shows a simple experimental arithmetic cell containing 27 tunnel diodes, using resistive coupling throughout and powered from a transistorized three-phase pulse supply. Repetition rate is 1 mc. Unit demonstrates the operation of all the basic logic circuits including dynamic storage.

CROSSED FILM CRYOTRON—Crossed film cryotrons deposited on insulated superconductors have been applied to switching and storage circuits.[9] A shift register circuit has been deposited in an area corresponding to 20,000 active elements a square foot. Calculations show that with this component density a computer or memory containing more than one million elements can be accommodated in a one-cubic-foot liquid helium container using presently available refrigeration methods.

An experimental crossed film cryotron has a time constant of less than one microsecond and is approximately 100 times faster than the original vacuum deposited cryotron. The d-c dissipation is less than five microwatts and the active area of each element is approximately 5×10^{-4} square centimeter. Cryotrons and all interconnecting circuitry can be vacuum deposited at the same time in a few simple steps.

Basic structure of a crossed film cryotron is shown in Fig. 6. Device is made up of tin, lead and insulator films. Of these only the tin films change their state

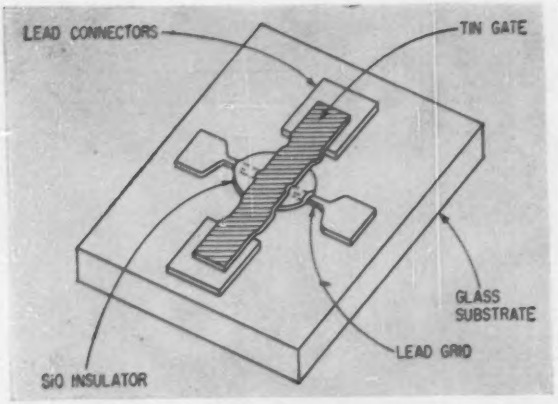


FIG. 6—Crossed film cryotron is approximately 100 times faster than original vacuum deposited cryotron

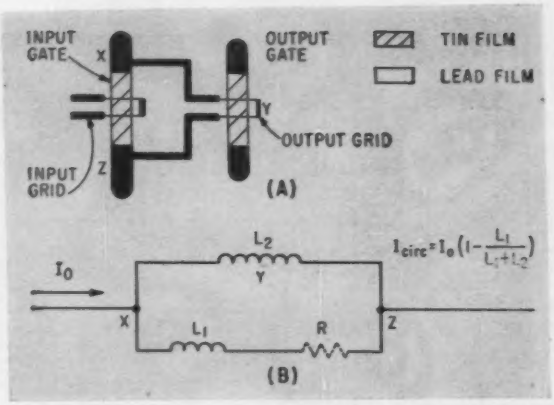


FIG. 7—Cryotron storage cell (A) with equivalent circuit (B) has been applied to a shift register. (See the front cover)

during operation. If a sufficiently large current is passed through the grid film, the resulting magnetic field produces a resistive channel across the much wider tin gate film. The grid remains superconducting at all times.

Shielded cryotron using a shield insulation thickness of about four microns has been found to be an order of magnitude faster than the unshielded. A tin film which lies adjacent to a lead shield plane has a higher critical current than a similar tin film deposited on glass because of the field configuration. A film in the shape of a cylinder will carry twice as much current as the same film unwrapped into a flat plate. When current passes through a tin film adjacent to a superconducting shield, surface currents are induced in the shield to prevent flux penetrating into it. These surface currents double the field between the film and the shield and produce an approximately zero field on the opposite side of the film. This field configuration is the same as would occur if the tin film were in the shape of a cylinder. So the critical current is increased from the value for the unshielded flat film to that for the cylinder.

Crossed film cryotrons make possible improved memory structures where each storage element can have logic associated with it. Memories appear as an attractive first application because their structure is repetitive and because they have many fewer logic levels than even the simplest computer. Figure 7 shows a cryotron storage cell and equivalent circuit.

Computers are presently built from plug-in circuit packages where each plug-in unit represents a few logical elements. Crossed film cryotrons make it possible to deposit the equivalent of a present-day rack of plug-in units on a small plate in a few hours. The problems of testing and fault correction in such a complex multilevel logic module are real but reportedly not greater for cryotrons than for any other component which would allow similar packing densities.

MAGNETIC DISK MEMORY UNIT—Principles of fluid motion discovered by Bernoulli are used in Laboratory for Electronics' Bernoulli disk to maintain a controllable and small separation between the storage medium and the read-write heads.

A flexible Mylar magnetic disk is rotated close to a smooth stabilizing backplate in which read-write heads are imbedded flush with the smooth surface. The tape disk is attached by flanges directly to the shaft of an electric motor, and an air inlet is located at the center of the backplate to permit air to enter between the rotating disk and the stabilizing plate.

When the tape disk is at rest, it falls away from the backplate; but in motion the limp disk becomes flattened by centrifugal force and the disk pumps air through the orifice and out at the disk periphery. At this point the hydrodynamic forces of the air between the disk and the stabilizing plate, together with the dynamic and elastic forces of the revolving disk, cause the disk to conform to the backplate at a controllable separation.

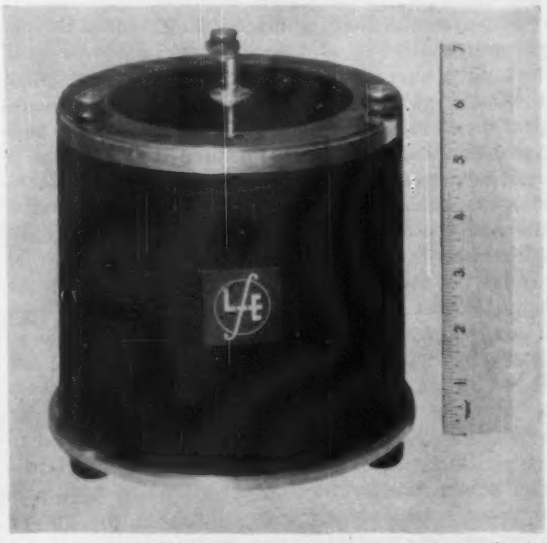


FIG. 8—Magnetic disk memory unit is designed to operate from a solar cell

Complete memory cylinder shown in Fig. 8 includes circular printed-circuit cards, 40 tracks and read-and-write amplifiers, solid-state matrix selection switch and inverter to run 400-cycle motor. Clock rate of various models will range from a few kc to 3 mc, depending on motor speed. Off-shelf item due in about four months will store 50,000-60,000 bits. Models with storage as high as one million bits are planned.

MINIATURE HIGH-DENSITY MEMORY—A 10-pound magnetic drum memory has been developed for airborne and missile weapons systems under an Air Force contract.[5] The unit can store 300,000 bits, operates at a clock rate of 546 kc, has a temperature range of 125 C to −50 C, and will withstand shock loads of 16 g and continuous vibration of 4 g peak up to 2,000 cps. The drum, shown in Fig. 9, stores information on 122 channels including seven circulating registers and can operate at peripheral speeds of 120 feet a second. The head-to-recording-surface spacing is achieved by mounting large numbers of record-read heads in sliding pad assemblies. The pads are supported on the boundary layer of air above the drum and do not touch the recording surface. Technique amounts to an air bearing or gas lubrication. Record-read heads are so small that 30 a linear inch can be mounted side by side in a single pad. Head-to-drum spacing of 200-300 microinches is a compromise between cost and signal amplitude.

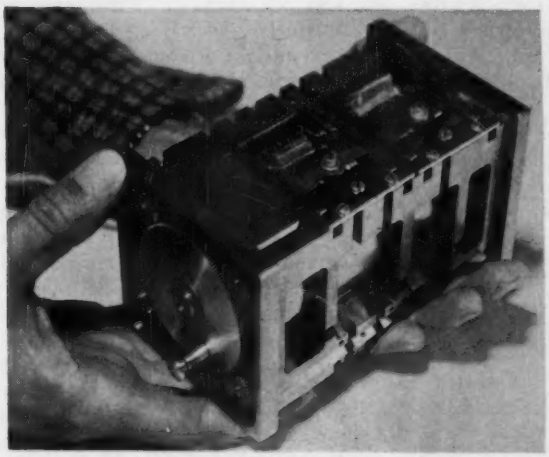


FIG. 9—Magnetic memory drum can store 300,000 bits of information, is operated at a bit rate of 546 kc

The sliding pads are self-aligning and self-adjusting. A single cantilever spring provides a force on two pivoted arms. Pivots on the arms force the pads against the drum by riding in V grooves in the pads. The V grooves are placed at a point on the pads such that a stable angle is maintained between pad and drum so that lift is obtained from the boundary layer of air around the drum. The calculated resonant frequency of the sliding pad (for small amplitudes) is about 3,000 cps and the mechanism appears to be more than critically damped.

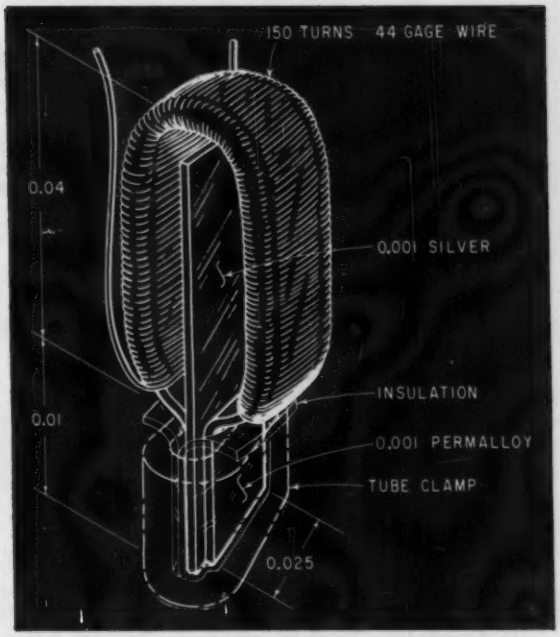


FIG. 10—Magnetic head consists of coil wound over four-layer core

Magnetic heads, essentials of which are shown in Fig. 10, feature small size and weight to make possible in-line assembly of 27 heads in a pad 1.25 inches wide. The head consists of a core of four layers of Permalloy over which the coil is directly wound. Core and winding is formed into a U shape whose legs are separated by a thin silver shim which forms the gap. After assembly, the pads are ground and finally finished by lapping. At present, read-back signals are 10-20 mv at 546 kc. Recording requires about 100 ma current. A six-volt transistor battery supply is sufficient for recording. Recording density can be increased up to 500 bits an inch with the present design.

A very hard nickel-cobalt magnetic plating was developed, using as a starting point an electroless plating method developed by the Bureau of Standards for nickel. The coating is said to have superior magnetic characteristics to iron oxide, and greater wear resistance. Coating saturates at 6,000 gauss, and demagnetizes to 3,200 gauss at the recording density of 350 bits per inch assuming a coating thickness of 150 microinches.

References

The papers listed below were all presented at the Eastern Joint Computer Conference, Boston.

(1) R. Rice, International Business Machines Corp., Poughkeepsie, N. Y., Computers of the Future.

(2) J. A. Rajchman, RCA Laboratories, Princeton, N. J., Solid State Microwave High Speed Computers.

(3) M. H. Lewin, RCA Laboratories, Princeton, N. J., Negative-Resistance Elements as Digital Computer Components.

(4) V. L. Newhouse, J. W. Bremer, H. H. Edwards, General Electric Co., Schenectady, N. Y., The Crossed Film Cryotron and Its Application to Digital Computers.

(5) M. May, R. A. Howard, G. Miller, G. Shifrin, Ramo-Wooldridge, Los Angeles, Calif., A High-Speed, Small Size Magnetic Drum Memory Unit for Micro Miniature Digital Computers.

Solid-State Guidance For Able-Series Rockets

Here are the transistorized circuits for guiding the Able series of probes into space. Lightweight, simple, reliable, these circuits may be applicable to many types of control

By ROBERT E. KING and HENRY LOW,
Members of the Technical Staff, Space Technology Laboratories, Inc., Los Angeles, Cal.

THE ABLE SERIES of missiles is being used for space exploration experiments. An Able missile consists of a Thor or Atlas first stage, a second-stage liquid rocket, a solid-propellant third stage, a solid- or liquid-propellant fourth stage, and an experiment package or payload.

The control system to be described is for the second stage. It makes the missile follow a predetermined course in response to commands generated by an internal programmer, or in response to guidance commands from the ground.

One of the primary design criteria for the second-stage attitude-control system was light weight without compromising the ability of the equipment to survive and operate in a high-vibration environment. Thus, this system uses transistor and magnetic-amplifier circuits instead of vacuum tubes. A novel modular design uses stacked etched circuit board. Weight of similar equipment in the earlier Able missiles was 120 lb. The corresponding control equipment described here weighs about 30 lb. Power requirements were reduced from 200 to 18 v-a.

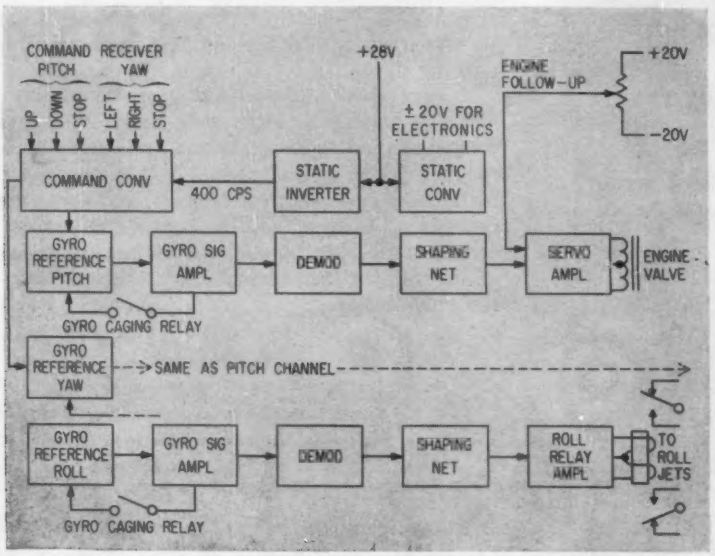


FIG. 1—Attitude-control system. Not shown here is the provision for internal programming in the command converter

Figure 1 shows the attitude-control system. The command converter normally converts signals from a command receiver; it can also establish an attitude program.

Receiver commands are converted to gyro torquing currents. Gyro output signals command pitch, yaw and roll channels. Pitch and yaw channels, which are identical, control missile attitude in these axes by gimbaling the second-stage rocket engine with hydraulic actuators. The roll channel operates pneumatic jets located on the periphery of the airframe.

A stop command from the receiver interrupts the gyro torquing currents. After being servoed to its new attitudes, the missile follows a constant course until the next gyro-torquing commands arrive.

Pitch and yaw channels have more than 10 db of gain margin and 30 deg of phase margin at all times during flight, without the complexity inherent in the use of rate gyros. A lead network with a break frequency of 2.5 radians per second provides rate damping, and an ad-additional lag term acts to stabilize for missile bending.

The roll control channel is a discontinuous on-or-off servo system which exerts a corrective torque on the missile for roll angles greater than 3 deg. This torque is obtained by the action of four fixed pneumatic jets which are controlled in pairs by solenoid-operated valves. Working fluid for the jets is helium, which is supplied from the

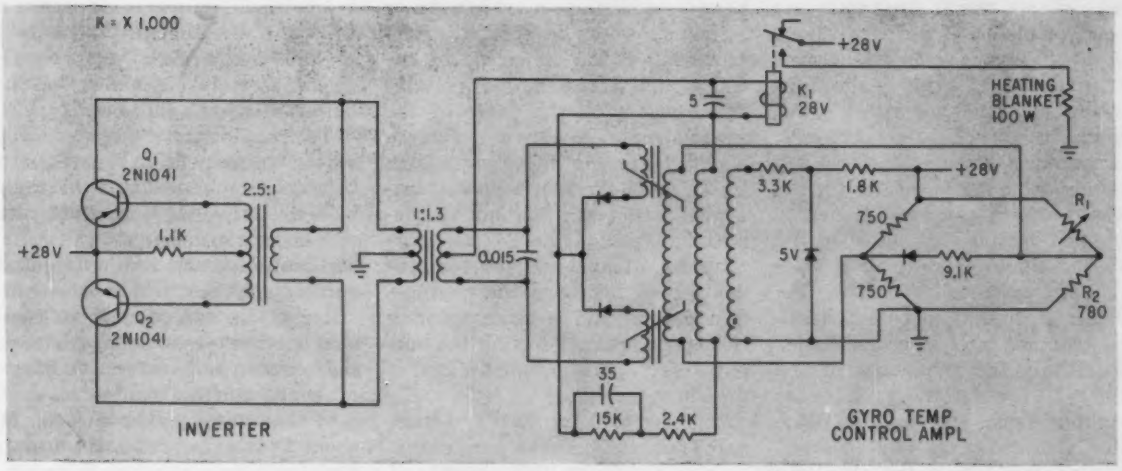


FIG. 2—Gyro temperature control connects and disconnects heater

propellant gas-tank pressurization system. Each jet can exert 15 lb of thrust. In flight, the missile roll attitude oscillates continuously at a fixed amplitude between the plus and minus 3-deg limits. Instead of a rate gyro, a lead network provides rate damping to minimize the pneumatic impulse requirements. A low-pass filter attenuates demodulator ripple. This filter has negligible effect on system dynamics.

Power from a 28-v silver-zinc battery is converted to 115 v, three phase, at 400 cps, which is then transformed to the distribution voltage of 10 v. A regulated plus and minus 20 v d-c for the control circuitry is produced by a transistorized static-converter voltage regulator.

Command Converter

Some of the commands that come from the receiver are: pitch up, pitch down, pitch stop, yaw left, yaw right, and yaw stop. These commands are received in the form of a relay contact closure which persists for 5 seconds. An arrangement of relays in the command converter causes these momentary contact closures to supply and maintain a constant a-c of the proper phase to the gyros, thus commanding the desired missile attitude change. Transmission of a stop command in a particular channel causes the current to be interrupted, and the missile will then follow a constant heading.

The command converter also has a provision for establishing an attitude program consisting of a constant pitch turning rate for a specified time. Turning rate is established by setting the current with a series rheostat, and time is established by a transistorized time-delay relay operating from a regulated d-c supply.

The command converter also contains a three-phase transformer which converts the 115-v output of the static inverter to the 10 v required by the gyro spin motors and demodulator reference transformers.

Gyro References

Each channel of the gyro reference assembly has a body-mounted hermetic integrating gyro of the HIG-4 type, a gyro temperature-control amplifier, circuits to excite the gyro, and spin-motor monitoring circuits.

Each gyro is mounted with its input axis parallel to either the pitch, roll or yaw axis of the missile; hence, each is sensitive to attitude deviations in only one axis.

Gyro temperature is regulated to $\pm\frac{1}{2}$ F by a temperature-control amplifier (Fig. 2). The amplifier senses differences between gyro-mounted, temperature-sensitive resistance R_1 and fixed resistance R_2, both connected in a bridge circuit. If the gyro temperature is higher or lower than the desired 165 F, the bridge has an output. This voltage goes to the control winding of a high-gain single-stage magnetic amplifier, which de-energizes or energizes relay K_1; the closed relay contacts connect a heater element within the gyro to the 28-v d-c power source. Operating frequency of the magnetic amplifier is 1 kc, permitting use of relatively small cores. This h-f power is generated in a two-transistor (Q_1, Q_2) low-power static inverter.

Gyro heat losses and heating power requirements were reduced by mounting the gyros in metal rings which are thermally isolated from the case by a dimensionally stable epoxy-glass mounting board. Each gyro is contained in a gold-plated, thin metal can, which reduces heat loss due to radiation. Each can is, in turn, encased in a thick molded-in-place shell of foamed polyurethane plastic. The foamed plastic adds structural rigidity to the entire package, and its thermal insulation property reduces warm-up time; the reduction in heater cycling increases the useful life of the control relays.

Current transformers are incorporated in one leg of each gyro spin motor. Before launching, the output of these current transformers is monitored on a recorder in the blockhouse. The current level indicates performance of the gyro spin motor.

Pitch and Yaw Channels

The pitch and yaw channels (Fig. 3) are identical, each containing a gyro signal amplifier,

demodulator, shaping network, and servo amplifier. The gyro signal amplifier uses silicon transistors Q_1, Q_2 and Q_3 to provide a voltage gain of 1.5 at 400 cps with a power output of approximately 100 mw. An amplifier phase shift of 50 deg lagging, which compensates for the phase shift of the gyro signal, is obtained by an R-C filter at the input of Q_1. In order to avoid loading the gyro signal generator, the necessary high input impedance was obtained by a large resistance (R_1, R_2) in the series arm of the filter. To prevent the gyro signal amplifier from loading the input filter, the first stage has an input impedance of approximately 100,000 ohms. The three amplifier stages are direct coupled, and base bias for the first stage is obtained from the voltage developed across resistor R_3. This feed-back arrangement assures stability of the operating point of all three transistors despite variations of temperature and of transistor parameters.

The amplifier gain is obtained in the first stage, which is operated as a heavily degenerated amplifier.

Gyro signal amplifier coupling to demodulator transformer T_1 uses capacitor C_1 to avoid saturation of the transformer core by the d-c component of the amplifier output. The demodulator is a full-wave sum-and-difference type using four silicon diodes. Input to the demodulator from T_1 is a 400 cps signal; demodulator output is a d-c or l-f signal whose amplitude is proportional to the amplitude of the input signal and whose polarity is dependent on the phase of the input signal. A 400-cps reference signal is fed to the demodulator by T_2, an 80-v center-tapped transformer. Output circuits of the demodulator include an R-C low-pass filter to attenuate ripple components resulting from the rectification process and a balance potentiometer to permit setting the output to zero when no input signal is present.

The demodulator has a voltage gain of 9.4 and provides a maximum output of ± 60-v with a linearity of 3 percent of full scale.

The shaping network which follows each demodulator is a lead-lag resistance and capacitance network which provides the desired anticipatory system response.

The servo amplifier is a direct-coupled differential amplifier with a gain of 5 differential ma per volt of input. Output differential current goes to a dual-coil hydraulic valve. Maximum linear output is 10 differential ma into a dual 1,000-ohm-coil valve.

The amplifier has two inputs: one from the shaping network which represents attitude error of the missile, and one from the engine follow-up potentiometer which represents engine gimbal angle. In operation, the amplifier causes a current to flow in the hydraulic valve which causes engine motion in such a direction that the output of the engine follow-up potentiometer R_3 will equal and cancel the output of the shaping network.

To reduce drift effects, seven silicon transistors are used in a balanced configuration with their base-emitter voltages matched. Use of Sensistors further reduces drift. The last stage acts as a differential current amplifier, which uses transistor Q_4 instead of a large common emitter resistor to minimize the common-mode effect. A range of temperatures from + 20 C to +65 C causes a maximum drift of about 2 percent of full-scale output. Emitter followers in the servo amplifier's input stages provide high input impedance and avoid loading effects on the shaping networks.

Roll Channel

The gyro signal amplifier and demodulator of the roll channel are identical to those of the pitch and yaw channels. As shown in Fig. 4, a signal from the roll-channel demodulator goes to its roll shaping network, which applies it to the switching amplifier.

The roll switching amplifier is composed of two sections. The section whose input transistor is Q_1 operates for positive error signals and the section whose input transistor is Q_2 operates for negative error signals.

Trasistors Q_1 and Q_2 operate as a cascaded emitter follower to ob-

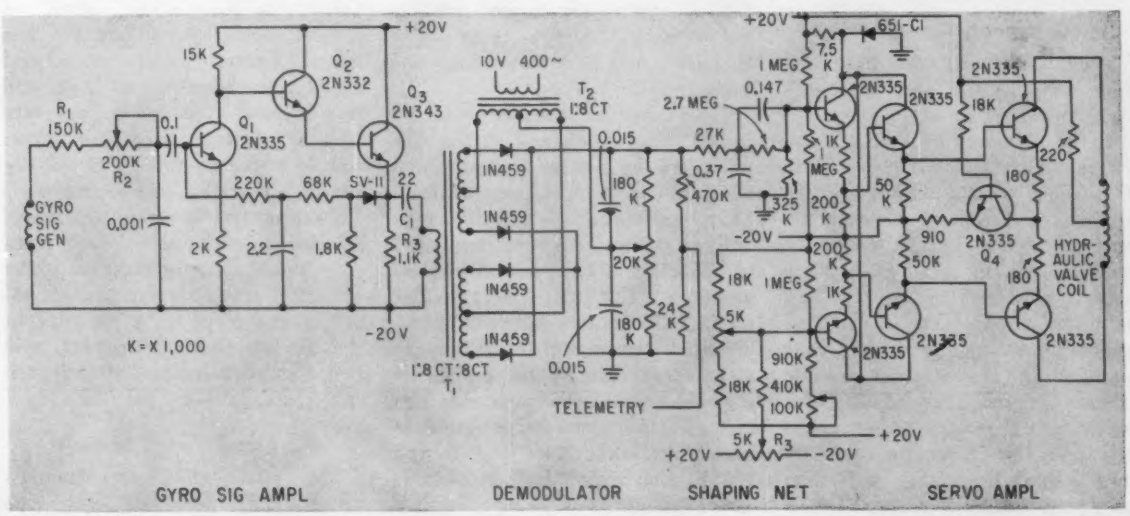


FIG. 3—This is the schematic of either the pitch or the yaw channel; channels are identical

tain a high input impedance. An input impedance of one megohm is necessary to prevent loading the shaping network and changing frequency-response characteristics of this network. Output of the emitter followers activates a Schmitt trigger circuit, and a 10,000-ohm potentiometer sets the input level at which the trigger circuit will operate. This potentiometer is normally set so that the trigger actuates at a shaping-network voltage output corresponding to 3 deg of missile-attitude error; this voltage is approximately + 2.5 v.

The Schmitt trigger is arranged so that in the OFF state transistor Q_4 conducts heavily and Q_5 is effectively cut off. When the input signal reaches the proper value Q_5 starts to conduct, turning off Q_4. When Q_4 turns off, the voltage at its collector rises toward the + 20 v and in so doing sufficient current is supplied to the base of Q_6 to turn it on. Transistor Q_6 now causes Q_7 to conduct, thereby energizing pilot relay K_1 and actuating the clockwise solenoid valve. Since relay K_1 requires approximately 100 ma to actuate and the saturation resistance of Q_7 is 5 ohms, only 50 mw of power is dissipated in the transistor in the ON state. Silicon diode D_1 is connected across the relay coil to protect the 2N389 driving transistor from inductive transietents.

The other section of the roll switching amplifier is essentially the same in function as the section just described. However, this circuit is energized by a negative voltage input and *pnp* transistors are used in place of *npn* types. Since the output circuit uses *npn* types it was necessary to include two additional stages to change the level and polarity of the base drive to Q_8.

In both of these switching circuits the hysteresis was adjusted to be less than 1 percent for reasons of missile dynamic stability and to minimize the amount of gas used in correcting roll-attitude deviations.

Power Supply

The power supply for the channels consists of a commercially available transistorized static converter-regulator which provides ± 20 v d-c regulated to ± 1 percent. Prime power is obtained from the 28-v missile battery.

The static inverter consists of an oscillator, semiconductor power switches, control circuits, and output filters.[2]

The open loop gyro torquing technique used to program missile maneuvers imposes strict limits on voltage and frequency regulation. Total angle through which the gyros are torqued is a function of the gyro's angular momentum, the torquer current, and time; thus it is necessary to hold each of these factors to close tolerance in order to achieve a precise program.

Since angular momentum depends on wheel speed, which in turn is dependent on frequency, the frequency is regulated to ± 0.25 percent. Since gyro torquing current depends on supply voltage, it is necessary that the output voltage of the static inverter be regulated to ± 0.5 percent. These tolerances were determined from trajectory considerations.

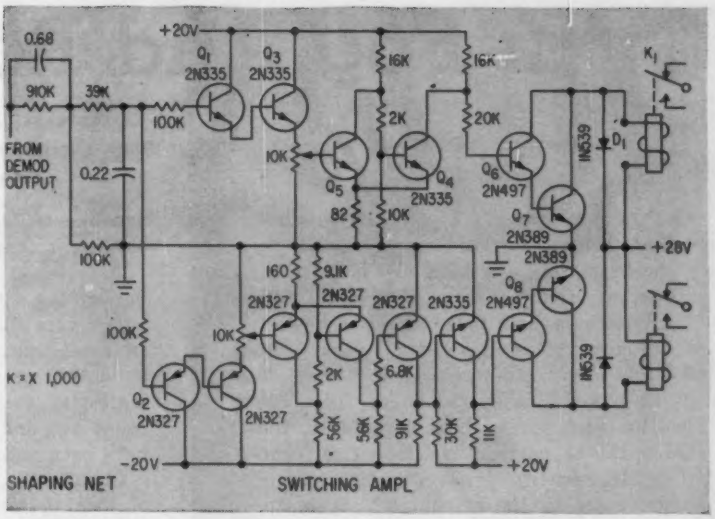


FIG. 4—Roll channel. Since gyro signal amplifier and demodulator are same as those of pitch and yaw channels, they are not shown

Environmental Testing

On the basis of data obtained from Vanguard, Jupiter, Redstone, Thor, and other missile flights, it was estimated that maximum vibration levels would be near 3-g rms over a 5 to 2,000-cps range for the second-stage powered flight, with a burst of somewhat higher vibration levels at second-stage cutoff.

The equipment described was designed to withstand environmental specifications more severe than field or flight conditions in order to provide better assurance of locating design faults. These test environments were not intended to be severe enough to exceed reasonable safety margins or to excite unrealistic modes of failure.

Packaging

Electronic packaging is unusual in that individual circuits are assembled on separate etched wiring boards which are stacked vertically. Interconnections between boards are made by flat-tape cables, which permit the whole assembly to be unfolded for servicing and checkout. Size and weight are reduced and reliability is increased by eliminating plugs and keeping the number of soldered connections to a minimum.

A separate test plug is provided on each package for checkout of the control system after it is installed. Calibration and testing of the system is done with simple equipment.

References

(1) R. R. Bennett, G. J. Gleghorn, L. A. Hoffman, M. G McLeod and Y. Shibuya, Circuits for Space Probes, ELECTRONICS, June 19, 1959.

(2) D. W. Moore and R. D. Gates, Special Report on the Solid Inverter, *Western Aviation*, Nov. 1958.

In Fog And Rain—Sight,

By M. E. SEYMOUR, Advanced Electronics Center, General Electric Co., Ithaca, New York

DECREASE IN PERFORMANCE of a detection system is, in general, largest during weather conditions in which the scattering particles are near in size to the wavelength used for detection. Visual detection is difficult in haze and fogs, infrared detection is difficult in heavy fogs and K-band radar detection is difficult in heavy rain.

Scattering occurs when the energy in a beam is absorbed by a particle such as a raindrop, then reradiated with the particle as a spherical center of radiation. Beam energy in the direction of propagation is decreased by the amount lost by scattering. When the scattering particles are much smaller than the radiation wavelength, scattering is proportional to $(a/\lambda)^4$, where a is the radius of the particle and λ the wavelength of the radiation (the Rayleigh relationship). When the particles are much larger than the radiation wavelengths, scattering depends only on the cross section and density of the particles. For this second condition, the attenuation depends on the amount of material in the path of transmission. A comprehensive mathematical treatment of scattering is contained in Reference 1. Figure 1 indicates the relationship between wavelength, particle size and scattering coefficient.

VISUAL DETECTION—An object can be detected by contrast with its background. Both positive and negative contrast are common; target radiation may be greater or less than background radiation, particularly during daylight hours.

Targets at temperatures belowe 1,000 K have low luminous efficiencies since they radiate little in the visible region. Therefore, they can be easily seen only by negative contrast, with maximum range for black targets. A useful estimate of range, assuming 5.5 percent detectable contrast[2] and targets of reasonable size is $R_v = 2.9/\sigma$, where σ is the scattering coefficient ($\exp[-\sigma R_v] = \exp[-2.9] = 0.055$).

A series of nomographs was devised for military use[3] giving range as a function of target area.

For pure air, the scattering coefficient is 0.015/km[4]. In haze, scattering coefficients range between this value and about 4/km. The condition in which the scattering coefficient is greater than about 4/km is called fog, and coefficients at least as large as 40/km have been measured.

In rain, the scattering coefficient, σ_s, is a function of rainfall intensity, Z, usually measured in millimeters per hour. For orographic rain (rain caused by the rising of moist air up mountain slopes), $\sigma_s = 0.25Z^{0.63}$; for nonorographic rain, $\sigma_s = 1.2Z^{0.63}$. It is surmised that drizzle has a coefficient close to σ_s. These coefficients are representative if there is no fog or dust, and rain is the only obstruction to visibility.

INFRARED DETECTION—Although negative contrast is used in infrared, most applications use positive contrast. Targets at temperatures above 300 K are generally detectable; targets at lower temperatures have spectral distributions of energy peaked at longer wavelengths. Low altitude ir (infrared) detection is limited even in clear weather by the selective absorption of atmospheric water vapor and carbon dioxide. The equation for ir is $H_\lambda = J_\lambda T_A (\lambda, R) \exp(-\sigma_\lambda R)/R^2$ where H_λ is irradiance at ir receiver in watt/cm^2, J_λ is radiant intensity of target in watts/steradian, and T_A (λ, R) is transmittance of the clear atmosphere. The overlapping effects of many closely spaced absorption lines prevent a simple exponential expression being adequate for T_A (λ, R), but procedures for calculating this transmittance have been established[5].

Table I—Coefficients for Range Calculations

Atmospheric Condition	Fog Density, ρ in g/m^3	Rain Intensity Z in mm/hr	Scattering Coefficients σ, in db/km, for λ in microns 0.5	2	10	3000	9000
Light Fog	0.032	...	20.7	4	1.3	0.12 + 1	0.021 + 0.18
Heavy Fog	2.3	...	413	413	220	9.5 + 1	1.5 + 0.18
Light Rain	.....	1	1.09	1.09	1.09	0.95 + 1	0.22 + 0.18
Heavy Rain	.....	16	6.24	6.24	6.24	8 + 1	3.5 + 0.18
Cloudburst	.....	100	19.8	19.8	19.8	33.3 + 1	22 + 0.18

IR or Radar?

Infrared scattering coefficients are much smaller than visual coefficients for weather conditions in which small particles predominate, since the λ^{-4} law then holds. For example, the coefficient at 10 microns in haze is less than one tenth that in the visible. In fogs the difference is smaller, with coefficients at 10 microns being about one half those in the visible region. In rain, ir scattering coefficients should be identical with visual coefficients, since raindrops are still much larger than the useful wavelengths of ir (wavelengths shorter than 15 microns).

Maximum infrared detection range R_i occurs for the minimum useful value of H_λ. Separating all factors dependent on range, $R_i\ T_\lambda\ (\lambda, R)^{-1/2}\ e^{R/2} = [J_\lambda A_o / NEP\ (s/n)]^{1/2}$ where NEP = noise equivalent power, s/n = minimum useful signal-to-noise ratio, A_o = collecting area of system and $NEP\ (s/n)/A_o = H_{min}$.

RADAR DETECTION—Active radar systems are limited by atmospheric absorption and scattering also, particularly at short wavelengths (less than 1 cm), with water vapor and oxygen the most important absorbing molecules. For a two-way path, radar energy reflected from small targets to the receiver is $H = kP_T \exp(-2\ \sigma_e\ R)/R^4$ where P_T is transmitted power, and σ_e is the combined attenuation coefficient for scattering and absorption.

Working values of scattering coefficients in rain and fog are provided by empirical expressions.[6, 7, 8]

Wavelength (cm)	3.2	1.8	1.24	0.9
Rain	$0.0017Z^{1.21}$	$0.010Z^{1.14}$	$0.028Z^{1.05}$	$0.051Z^{1.0}$
Fog	0.0483ρ	0.128ρ	0.311ρ	0.647ρ

Values are for temperatures of 18-20 C.[5] Density ρ is in g/m³ and Z is intensity in mm/hr.

Maximum radar detection range R_r occurs for minimum useful value of H; $R_r \exp(\sigma_e R/2) = (kP_T/H_{min})^{1/4} = R_r\ 10^{0.05aR}$ where a is attenuation in db per unit of range ($\sigma = 0.23a$).

RANGE AGAINST AIRCRAFT—A typical problem is that of detecting aircraft. The following assumptions will be made to afford a basis of comparison.

1. The target is a twin-engine aircraft with 800 K emission from hot parts of 375 watts per steradian, equivalent to a black body with a projected area of 0.05 m².

2. The ir system has a collecting area of about 500 cm² and two types of detectors; lead-sulfide, PbS, with NEP of 10^{-10} watts in the 1.8 to 3 micron region (germanium filter cutoff at 1.8 micron); and thermistor bolometer with NEP of 10^{-8} watts in the same range with useful s/n of 4.

3. The 0.9 cm and 0.3 cm radar systems have a range, for no scattering or absorption, of about 10

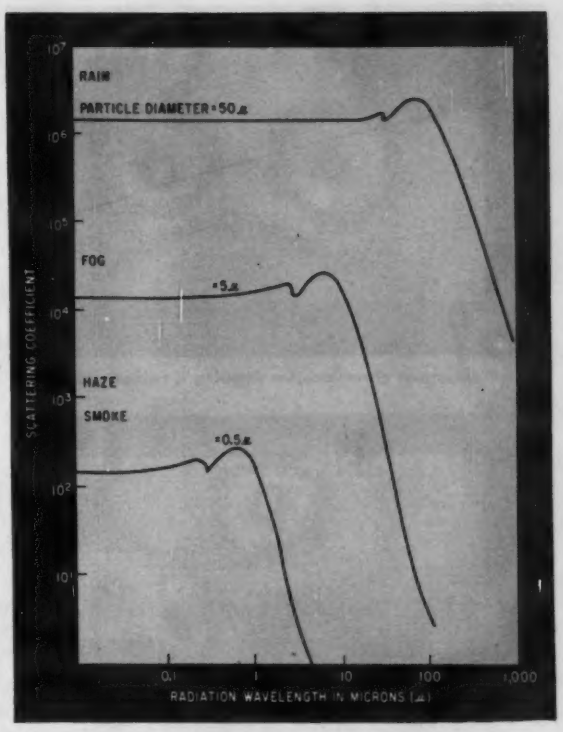


FIG. 1—Scattering coefficient plotted against particle size and radiation wavelength

TABLE II—Comparison of Range

Atmospheric Condition	Maximum Range (km) Against Aircraft					Maximum Range (km) Against Auxiliary Lights			
	Visual	Infrared		Radar		Visual		Infrared	
	(Daylight only)	PbS	Bolometer	0.3 cm	0.9 cm	Overcast Day	Night	PbS	Bolometer
Light Fog	0.61	1.7	3.7	5.2	9.8	0.44	1.5	9.3	6.8
Heavy Fog	0.031	0.13	0.17	1.6	4.4	0.008	0.050	0.18	0.20
Light Rain	11.5	9.4	3.8	4.1	7.2	16.0	40.0	25.0	7.5
Heavy Rain	2.0	3.8	2.5	1.7	2.9	0.72	3.8	6.5	2.9
Cloudburst	0.64	1.4	0.89	0.30	0.93	0.45	1.6	2.5	1.3
Overcast	12.5	27.0	6.1	5.4	8.5	24.0	65.0	800.0	19.0

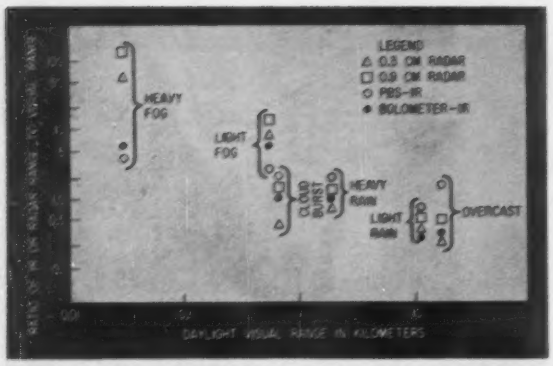


FIG. 2—Comparison of methods for detecting a twin-engine aircraft

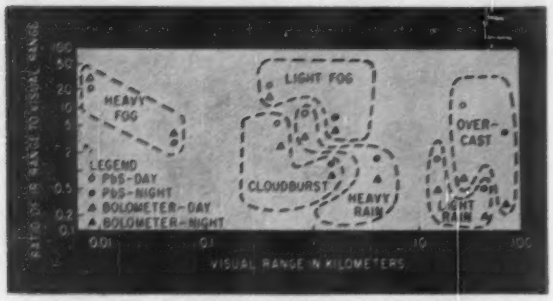


FIG. 3—Performance of infrared against auxiliary lights

km for the target.

4. Temperature is 18 C and absolute humidity is 15 g/m³ (100 percent relative humidity).

Table I shows the fog and rain conditions and lists the coefficients for the range formulas.[6, 8, 9, 10]

The equations will be worked out for the condition of light fog. From the assumed conditions, visual range (negative contrast), is $R_v = 0.61$ km.

Infrared detection range using a lead sulfide cell can be obtained by factoring an estimate of T_t in the expression for effective radiation[5], $R_t 10^{0.65 \times 1.8} = [(375 \times 0.03)\ 5 \times 10^{-6}/10^{-10} \times 4]^{\frac{1}{2}} = 37.4$ km. By an iterative process, the answer is found to be approximately, $R_t = 1.7$ km.

The solution for range with ir bolometer is similar; $R_t\ 10^{0.65 \times 1.8\ R} = [(375 \times 0.08)\ 5 \times 10^{-6}/10^{-6} \times 4]^{\frac{1}{2}} = 6.12$ km. Therefore $R_t = 3.65$ km.

Range with 0.9 cm radar is $R_r\ 10^{0.65 \times 0.2\ R} = 10$ km; $R_r = 9.8$ km.

Range with 0.3 cm radar is $R_r\ 10^{0.65 \times 1.19\ R} = 10$ km and $R_r = 5.2$ km.

The above results are listed in Table II along with the results of similar calculations for other atmospheric conditions. For the assumed conditions, the 0.9 cm radar performs better than the 0.3 cm set. Except in light rain, one or the other of the ir systems has a greater range than vision. Ranges for the radars are of course limited by their maximum assumed range of 10 km.

RANGE AGAINST AUXILIARY LIGHTS—Targets will be assumed to be auxiliary light sources at 3,000 K (emissivity of 1), with ir-transmitting optical material used for protecting windows (50 percent transmission in the band from 1.8 to 13 microns), and a total projected area of 0.02 m². The luminous intensity is thus about 3×10^5 candles.

The ir systems have the same sensitivities as in the previous example, and the temperature and humidity are the same.

Attenuation coefficients for the various weather conditions are the same and are listed in Table 1.

Only the calculations for light fog will be worked out. Ranges for the various weather conditions are listed in Table II.

From referenced material $R_v = 0.44$ for an overcast day (background luminance of 100 ft lambert), and $R_v = 1.5$ km for a background of starlight (10^{-4} ft lambert).

For ir detection with PbS cell, $R_t\ 10^{0.65 \times 1.8} = [(7.3 \times 104 \times 0.05)\ 5 \times 10^{-6}/10^{-10} \times 4]^{\frac{1}{2}} = 676$ km, from which $R_t = 9.3$ km.

For ir detection with bolometer, $R_t\ 10^{0.65 \times 1.8\ R} = [(7.3 \times 10^4 \times 0.004)\ 5 \times 10^{-6}/10^{-6} \times 4)^{\frac{1}{2}} = 19.1$ km, from which $R_t = 6.8$ km.

The above calculated results, as well as those for other weather conditions, are tabulated in Table II. The same data is plotted in Fig. 2 and 3.

CONCLUSIONS—Simple expressions can be used to estimate the performance of infrared and radar systems in rain and fog. Sample calculations indicate the different degrees to which several types of ground-level ir and radar systems are affected. For the typical examples chosen, maximum range calculations on a reciprocating engine aircraft reveal the following:

1. In fog, long-wavelength ir systems are superior to short-wavelength systems, but radar systems are still better, especially in heavy fog.

2. In rain of intensity ranging from light to cloudburst, short-wavelength ir systems are better than other ir or radar systems.

3. Radar performance is degraded seriously in the millimeter region, particularly in heavy rain.

Auxiliary light sources could be used to improve ir performance. For such targets, long-wavelength systems are best in heavy fog, but short wavelength systems are superior under other weather conditions, both day and night. The higher sensitivity possible at short ir wavelengths is an important factor here.

References

(1) H. C. Van de Hulst, "Light Scattering by Small Particles," John Wiley & Sons, Inc., New York 1957.
(2) D. Atlas, "Optical Extinction by Rainfall," *J. Meteorology*, **10**, p 486, Dec. 1953.
(3) S. Q. Duntley, The Reduction of Apparent Contrast by the Atmosphere, *J. Optical Soc. of America* **38**, p 179, 1948.
(4) W. E. K. Middleton, "Vision Through the Atmosphere," U. of Toronto Press, 1952.
(5) T. Altshuler, A Procedure for Calculation of Atmospheric Transmission of Infrared, *General Electric Co. Report* R57ELC15, May 1957.
(6) D. Atlas, *et al*, Weather Effects on Radar, *Air Force Surveys in Geophysics* No. 23 AFCRC, Dec. 1952.
(7) W. M. Hall, Prediction of Pulse Radar Performance, *Proc. IRE* Feb. 1956.
(8) D. E. Kerr, Ed, "Propagation of Short Radio Waves," MIT Rad. Lab. Series **13**, McGraw-Hill Book Co., New York, 1951.
(9) A. Arnulf, *et al*, Transmission by Haze and Fog in the Spectral Region 0.35 to 10 microns, *J. Optical Soc. of America*, **47**, p 491, June 1957.
(10) H. Theissing and P. Caplan, Atmospheric Attenuation of Millimeter Radiation, *J. Applied Physics*, **V27**, p 543, 1956.

Detecting Signals By Polarity Coincidence

Weak low-frequency signals in a high noise background can be detected by this polarity coincidence multiplier. Output indicates presence and phase shift of signals received at dual inputs

By **BERNARD M. ROSENHECK,** Columbia University, Hudson Laboratories, Dobbs Ferry, N. Y.

POLARITY COINCIDENCE MULTIPLIERS can be used as detectors of weak signals in the presence of noise, as phasemeters, or as infinitely clipped correlators. Using digital techniques, the multiplier shown functionally in Fig. 1 features low drift and 1-percent accuracy for inputs of 1 to 500 cycles.

The output of the multiplier is a measure of the probability that its two input signals have the same polarity. A maximum output occurs for two signals perfectly in phase whereas no output occurs for signals 90 degrees out of phase. If the input signals have the same frequency, the output depends upon the relative phase of the signals, and the instrument acts as a phasemeter.

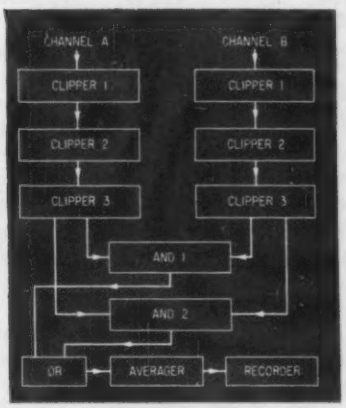


FIG. 1—Functional diagram of polarity multiplier does not include calibration circuit

When noise adds to the input signals, out-of-phase random peaks are introduced, reducing the output. When the signal-to-noise ratio is above 4 to 1, the addition of noise has essentially no effect; at a signal-to-noise ratio of 1 to 1, a maximum output of 1 is reduced theoretically to 0.733.

Theory indicates that when only the polarity signs of the signals are retained, a surprisingly small amount of information is sacrificed.[1] This method allows the signals to be processed in a digital manner, making possible a low-drift, simple and accurate instrument.

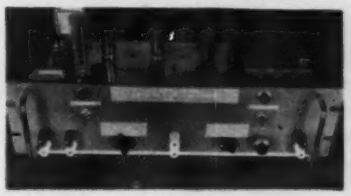
System Description

The instrument consists of two signal channels designated in the functional block diagram (Fig. 1) as channel A and channel B. These channels pass the signals through three stages of clippers, the clippers[2] ideally performing the mathematical operations

$$F(t) = \begin{cases} +K \text{ when } f(t) > 0 \\ -K \text{ when } f(t) < 0 \end{cases}$$

where $f\ (t)$ is the clipper inputs and $F\ (t)$ the outputs. Outputs equal a positive voltage K for inputs above the zero voltage axis and a negative voltage $-K$ for inputs below the zero voltage axis.

Clipped signals from the two channels are multiplied by a sign multiplication process. If the signals are both positive or both negative at the same time, the multiplier yields its output; if they have different signs, no output occurs.



Front view shows how instrument is constructed for relay rack mounting

Four-quadrant multiplication is accomplished by feeding one clipped set of input signals having the original phase into an AND circuit. The AND circuit produces an output only when both of its inputs are negative at the same time; if one or both inputs are positive, no output will occur. Simultaneously, phase-inverted replicas of the clipped signals obtained from the third clipper stages feed into a second AND circuit. The second AND circuit produces an output only when both of the original inputs are positive at the same time. The outputs of the two AND circuits drive an OR circuit which yields an output whenever one of the AND circuits operates. Only one AND circuit can operate at a time.

Figure 2 illustrates the waveforms occurring in the multiplier circuits. The multiplier selects the $(+, +)$ or $(-, -)$ polarity combinations of the input signals and

rejects the combinations of (+, −) or (−, +).

The output of the multiplier is time-averaged (Fig. 1) and recorded on a pen recorder which retains a permanent copy of the time-average of the polarity coincidence of the two input signals and its variation about an average level.

Theory of Operation

Assume signals of some alternating nature, not necessarily sinusoidal, to exist at the input of both channels of the instrument. Superimposed upon these signals are random signals of instantaneous noise amplitude N having a Gaussian amplitude distribution with a mean value of zero and a variance N^2_{rms}. The probability density[3] of the noise amplitude N is

$$p(N) = [1/(2\pi)^{1/2}N_{rms}] \exp(-N^2/2N^2_{rms}) \quad (1)$$

The probability $P(\text{plus})$ that the amplitude $S+N$ is positive is the probability that N has a magnitude between $-S$ and ∞ when the signal is positive. Quantity S is a constant value equal to the rms value of a square-wave signal. Thus,

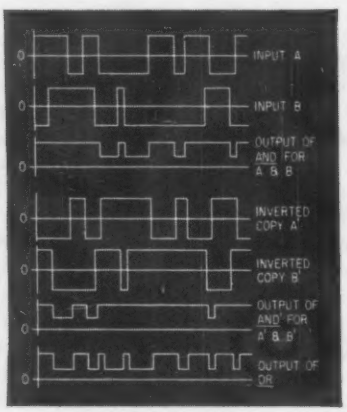


FIG. 2—Multiplier waveforms show how output depends upon polarity of inputs

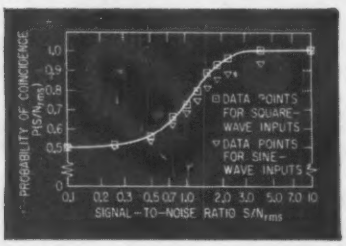

PROBABILITY OF COINCIDENCE P(S/N rms)
DATA POINTS FOR SQUARE-WAVE INPUTS
DATA POINTS FOR SINE-WAVE INPUTS
SIGNAL-TO-NOISE RATIO S/N rms

FIG. 3—Graph compares theoretical and experimental data

$$P(\text{plus}) = 1/(2\pi)^{1/2}N_{rms} \int_{-S}^{\infty} \exp(-N^2/2N^2_{rms})dN \quad (2)$$

Defining $t = N/\sqrt{2}\ N_{rms}$ yields

$$P(\text{plus}) = 1/\pi^{1/2} \int_{-S/\sqrt{2}N_{rms}}^{\infty} \exp(-t^2)dt \quad (3)$$

In terms of the Gaussian Error integral defined as

$$Erf(x) = 2/\pi^{1/2} \int_0^x \exp(-t^2)dt \quad (4)$$

therefore

$$P(\text{plus}) = \tfrac{1}{2}[Erf(\infty) + Erf(S/\sqrt{2}N_{rms})] = \tfrac{1}{2} + \tfrac{1}{2}\,Erf(S/\sqrt{2}N_{rms}) \quad (5)$$

The probability that the amplitude $S-N$ is negative when the signal is positive is

$$P(\text{minus}) = 1 - P(\text{plus}) = \tfrac{1}{2} - \tfrac{1}{2}\,Erf(S/\sqrt{2}N_{rms}) \quad (6)$$

For simplicity of analysis, assume that the signals of both channels are in phase, although the probabilities for any other case could be derived. Therefore, at any instant when both signals are positive, the probability that the resultant instantaneous amplitude of signal plus noise is positive for both channels is $P(\text{plus})^2$, and the corresponding probability that the amplitude is negative is $P(\text{minus})^2$. The probability that the sign of the amplitude is the same for both channels at any instant of time is therefore

$$P(S/N_{rms}) = P(\text{plus})^2 + P(\text{minus})^2 \quad (7)$$

Figure 3 is a plot of $P(S/N_{rms})$ vs. S/N_{rms}. It also compares experimental values with values calculated[4] from Eq. 7. Excellent verification of theory (within the 1-percent accuracy of the instrument) may be seen for the theoretical curve and the corresponding data points for square-wave signal inputs.

Circuits

The complete circuit diagram of the instrument is shown in Fig. 4. The clipper stages (V_1 to V_6) are identical symmetrical-differential amplifier stages.[5] Grids of each stage are held at a fixed bias of 50 v.

The input half section of each clipper stage may be considered a cathode follower. The common cathode signal in turn is the equivalent signal for the right-hand stage, which amplifies and limits the excursions of the signal.

Each time the signal passes through one of the cascaded clipper stages, its slopes become steeper, until, at the output of the third clipper, the signal is completely squared. For a 50-v sine wave at the input, the output of the third clipper will be a square wave with periods symmetrical to within 0.1 percent and slopes having rise times of less than a few microseconds. Reasonable square waves may be obtained from signals as low as 150 millivolts, although a 1-volt input is recommended.

Since the input of each clipper section is a cathode follower, grid current will not be drawn for large input signals. This is extremely important, for if grid current is drawn through the input coupling condenser on the positive half cycle of the input waveform, a net negative bias shift will occur (due to the charging of the condenser) producing asymmetry in the signal swing about the quiescent level of the stage.

The right-hand grids draw current, but as they are directly connected to the bias bus their bias level will not change.

Sign Multiplier Stages

Both half sections of the AND stages (V_7 and V_8) are quiescently biased in a full ON state. Their grid-to-cathode voltages are approximately zero and the tubes are drawing maximum current.

A change in state of these stages will occur upon application of a negative gate simultaneously applied to both grids, the tube going from full ON to cut off (zero plate current flow). Removal of one or both negative gates will cause the stage to resume its full ON condition. Application of a negative gate to one grid only will not turn the stage off as conduction of plate current still occurs in the other half of the stage. Diodes V_9 and V_{10} restore[6] the entire input signal below the quiescent level of the stage, thus insuring sufficient signal drive to cut the stage off.

Sign multiplication is achieved through use of two AND stages. Their outputs combine into one signal by the OR circuit, diodes D_1 and D_2. When either AND stage cuts off, the voltage at its cathodes tends to

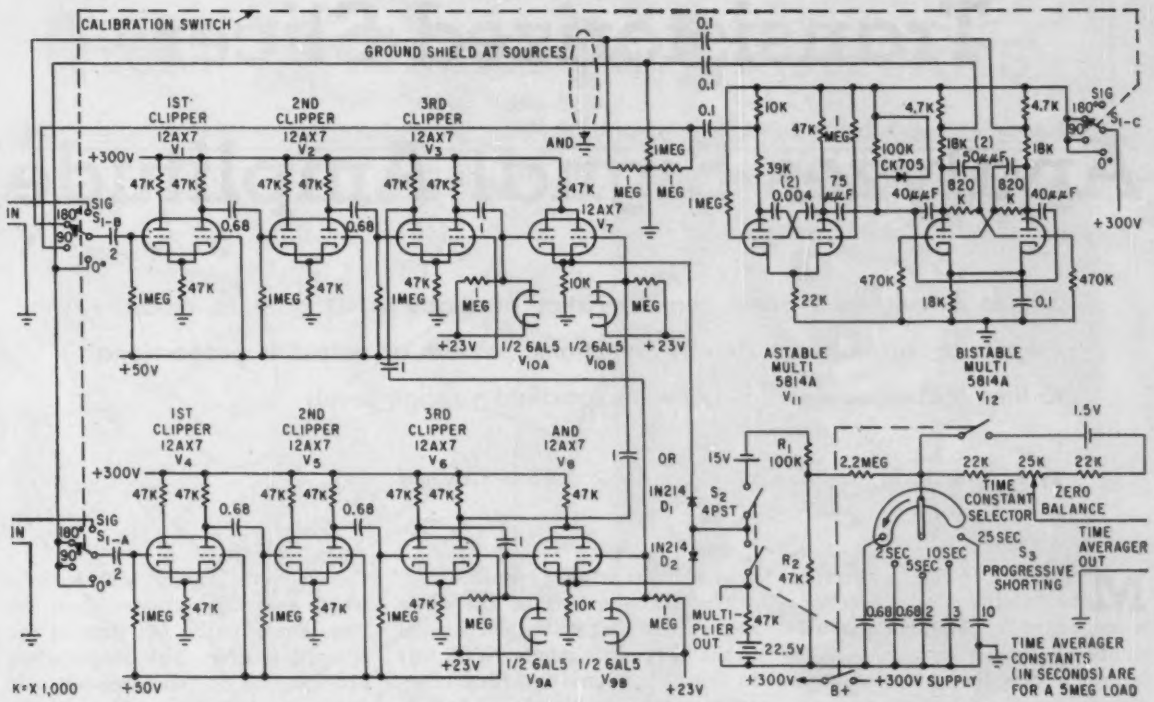


FIG. 4—All batteries used in multiplier are mounted inside a thermally shielded box in order to stabilize temperature. This insures low drift of output signal

falls to zero, allowing the OR circuit diode connected to these cathodes to conduct. Since the two AND stages act separately and at different times, the output of the OR circuit will show whenever both AND stages cut off, indicating the times when polarity coincidence occurs between the two input signals.

Time-Averager Circuit

A progressive shorting-switch type R-C filter time-averages the OR circuit's output, producing a d-c voltage proportional to the average output level of the OR circuit. Resistors R_1 and R_2 provide isolation between the filter and the OR circuit. This isolation insures linear filtering of the signal as the diodes offer different charge-discharge resistances for the filter condenser.

The 15-v and 1.5-v batteries, in conjunction with the ZERO BALANCE pot, allow bucking of the time-averaged d-c signal such that the 90-degree calibration switch position can correspond to zero output.

Calibration Circuit

Astable multivibrator V_{11} feeds bistable multivibrator V_{12} to produce a square wave whose period is symmetrical to within 0.1 percent. Outputs of the two multivibrators are fed into the clipper stages by the calibration switch to allow signals that are in phase and 180 degrees out of phase to pass through the system. At the 90-degree position of the calibration switch, the signal from the astable multivibrator is multiplied by the signal from the bistable multivibrator (at half the frequency), and the mean output is set to zero by adjusting the ZERO BALANCE pot.

Plate voltage is removed from these multivibrators when the calibration switch is at the signal position to avoid pickup from these stages.

Physical Description

A front view of the instrument is shown in the photograph. The front panel measures 19 in. wide (for relay rack mounting) by 5¼ in. high. The instrument is 10 in. deep and has a total weight of 10 pounds. The bottom plate of the chassis may be removed by loosening light self-taping screws.

Access to all signal connections is from the front through color-coded binding posts.

This instrument has been repeatedly tested and employed in the field to detect signals in the presence of noise. Excellent verification of theory was made both in the laboratory and in the field and surprisingly good correspondence between data and theory was found. The small size, rugged construction and freedom from excessive servicing requirements make the instrument suitable for multichannel experiments conducted at field laboratories.

This work was supported by the Office of Naval Research.

REFERENCES

(1) B. S. Melton and P. R. Karr, Polarity Coincidence Scheme for Revealing Signal Coherence, *Geophysics* **23**, 3, p 553, 1957.

(2) F. E. Terman, "Radio Engineering," p 597, McGraw-Hill Book Co., New York, N. Y., 1947.

(3) S. O. Rice, Mathematical Analysis of Random Noise, *Bell System Technical Journal*, **23-24**, 1944-1945.

(4) Table of Error Function and Its Derivatives, *National Bureau of Standards, Applied Mathematics Series*, No. 41, Government Printing Office, 1954.

(5) G. Valley and H. Wallman, "Vacuum Tube Amplifiers," p 441, MIT Radiation Lab Series, **18**, McGraw-Hill Book Co., New York, N. Y., 1948.

(6) J. Millman and H. Taub, "Pulse and Digital Circuits," p 119, McGraw-Hill Book Co., New York, N. Y., 1956.

Transistorized Slicer Analyzes Signal Amplitude

Simple circuit uses basic characteristics of diode AND gate to measure amplitude probability density functions. Width of output is proportional to time that input signal is between specified voltage levels

By **T. A. BICKART,** The John Hopkins University Radiation Laboratory, Baltimore, Md.

MEASUREMENT OF AMPLITUDE probability density functions is important in statistical measurements of signals and noise. The technique described here measures density functions by generating a rectangular pulse. Pulse width is proportional to the time that the signal being measured is between two specified voltage levels. This relationship is indicated in Fig. 1A.

Basic System

The basic system for making these measurements is shown in Fig. 1B. This technique employs the fundamental characteristics of the diode AND gate to establish a two-level Schmitt trigger circuit.

The characteristic of the diode AND gate is that its output is equal to the least of its inputs. With this in mind the signal handling characteristics of the inverter and diode AND gate, as illustrated in Fig. 2, are quite clear. If the triggering level of the Schmitt trigger following the diode AND gate is set at $-\Delta V/2$, then a pulse is generated whenever the signal is within the interval ΔV at $V = 0$. This is depicted in Fig. 2C and D. The level V can be assigned a value other than zero by adding to the signal a bias voltage equal to $-V$.

Transistorized System

A transistorized circuit embodying the principles just outlined is shown in Fig. 3. The circuit differs from the block system of Fig. 1B in that a diode limiter (D_1 and D_2) is employed to prevent overloading of the transistor inverter, Q_2. Diodes D_3 and D_4 are employed to control the pulse amplitude and level at the output of the Schmitt trigger. The pertinent operational characteristics of the circuit are:

Peak input signal	±5 v
Schmitt trigger	
Rise time (10 to 90 percent)	49 μsec
Fall time (90 to 10 percent)	19 μsec
Hysteresis	0.15 v

An operating range diagram for the circuit can be constructed with this information. It must be noted that the smallest-width, full-amplitude pulse that will emerge from the Schmitt trigger will have a width somewhat greater than the rise time plus the fall time of the Schmitt trigger. This is, then, approximately 80 microseconds. It must secondly be noted that the minimum window width is equal to the Schmitt trigger hysteresis voltage; this is apparent from the fact that with the width control set to a zero voltage on-triggering level the input signal must rise by a value equal to the hysteresis voltage before the off-triggering level is reached. With a sinusoidal input signal of radian frequency ω and peak amplitude E, the time spent by the signal at any one time in the

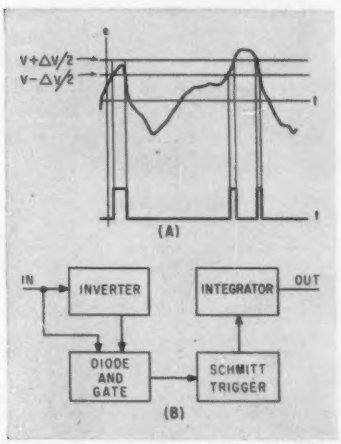


FIG. 1—Input-output characteristics (A) and block diagram (B) of amplitude probability density function measuring circuit

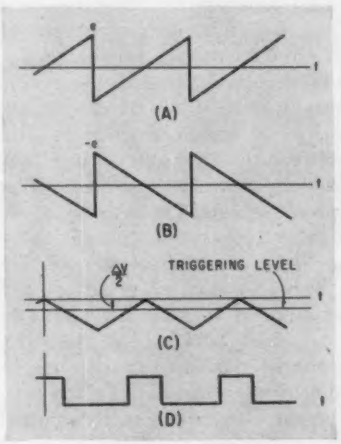


FIG. 2—Waveform of signal (A), inverter output (B), gate output (C) and Schmitt trigger output (D) indicate how system operates

PROFESSOR MIZZLE VON BOMB presents

Great Moments In Electronics

(Never Before Recorded)

IMACHIN' TAKING A DOG'S VORD OVER MEIN!

If Professor von Bomb had run a frequency curve before torturing his dog, he might be out of captivity now. SIE's ARP-2A Audio Response Plotter records everything in the audio range in chart form in seconds— keeps the SPCA from the door.

Frequency coverage	**20-20,000 cps**
AC signal levels, linear	**0-40 db**
DC volts, linear	**0-1 v**
Maximum sensitivity	**10 mv full scale**

"Zing Out" loud and clear for the SIE representative.

Write today for prices and specifications.

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.

A DIVISION OF DRESSER INDUSTRIES, INC.

10201 Westheimer • P. O. Box 22187 • Houston 27, Texas • HOmestead 5-3471

CABLE: SIECO HOUSTON TWX: HO-1185

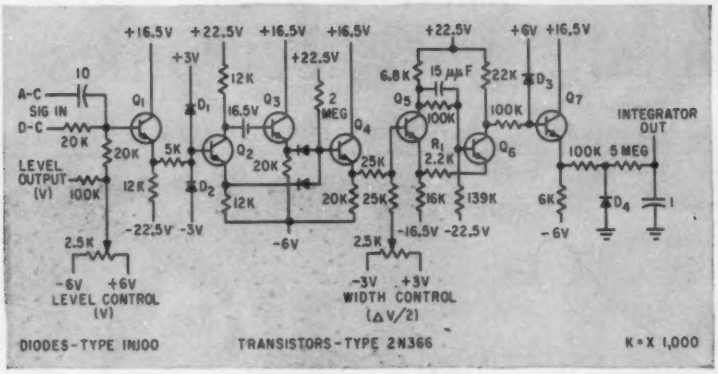


FIG. 3—Actual circuit differs only slightly from basic system outlined. Circuit can handle peak voltages of plus or minus 5 volts.

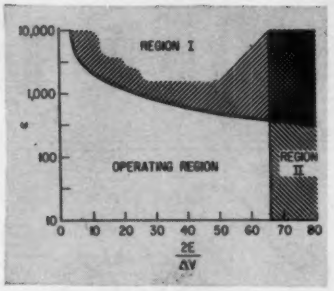


FIG. 4—Limits of operation are shown

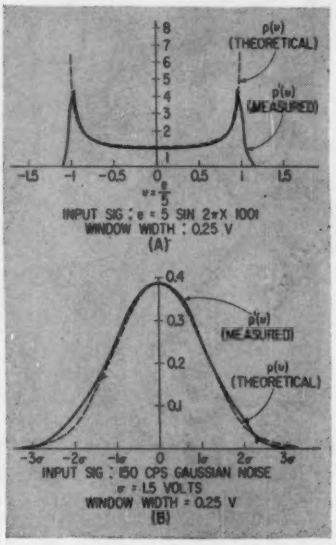


FIG. 5—Density functions for sinusoid (A) and Guassian noise (B)

interval ΔV centered at zero can be shown to be

$$\Delta t = \frac{2}{\omega} \text{ arc sin } \frac{\Delta V}{2E}$$

If $\Delta V << 2E$, then $\Delta t \approx \frac{2}{\omega} \frac{\Delta V}{2E}$,

The zero crossing interval was chosen to arrive at an expression for Δt, since, when the sinusoid is in the neighborhood of zero, Δt is a minimum. Now, on a plot of ω versus $E/\Delta V$, curves can be plotted which mark the limits of operation, this has been done in Fig. 4. Region I is restricted by the specification of the minimum Δt, and region II is restricted by the specification of the maximum peak signal. The curves are plotted on the basis of ΔV being set to its minimum value; this ensures the best possible approximation of the measured density function $p'(v)$ to the actual density function $p(v)$.

Conclusion

Measured density functions compare favorably with corresponding theoretical characteristics. This is shown for two common signals in Fig. 5A and B. In addition, the measured characteristic for the sinusoidal signal (Fig. 5A) is in excellent agreement with the expected characteristic for a finite window analyzer.[1]

The circuit functions well and requires component selection only in the case of the cathode coupling resistor in the Schmitt trigger (R_1 of Fig. 3). This resistor is chosen to reduce the Schmitt trigger hysteresis voltage to an acceptable minimum value.

The system, whether built with transistors or with vacuum tubes, appears to be sound in principle and is recommended for the measurement of amplitude probability density functions on the basis that there is no known or foreseen physical circuit characteristics which would result in poor measured data.

This work was supported by the United States Air Force under contract AF 33(616)-3374.

Reference

(1) T. A. Bickart, Low Frequency Amplitude Probability Density Analyzer, The John Hopkins University Radiation Laboratory Report RL/58/IMA-10, Sept 22, 1958.

THEORY OF MEASUREMENT

The amplitude probability density function of a signal voltage, v, is written p(v) and defined at $v = V$ to be

$$p(V) = \Delta V \overset{lim}{\rightarrow} 0 \frac{1}{\Delta V} P\left(V - \frac{\Delta V}{2} < v \leqq V + \frac{\Delta V}{2}\right)$$

where $P(V - \triangle V < v \leqq V + \triangle V)$ is the probability that v is within the interval

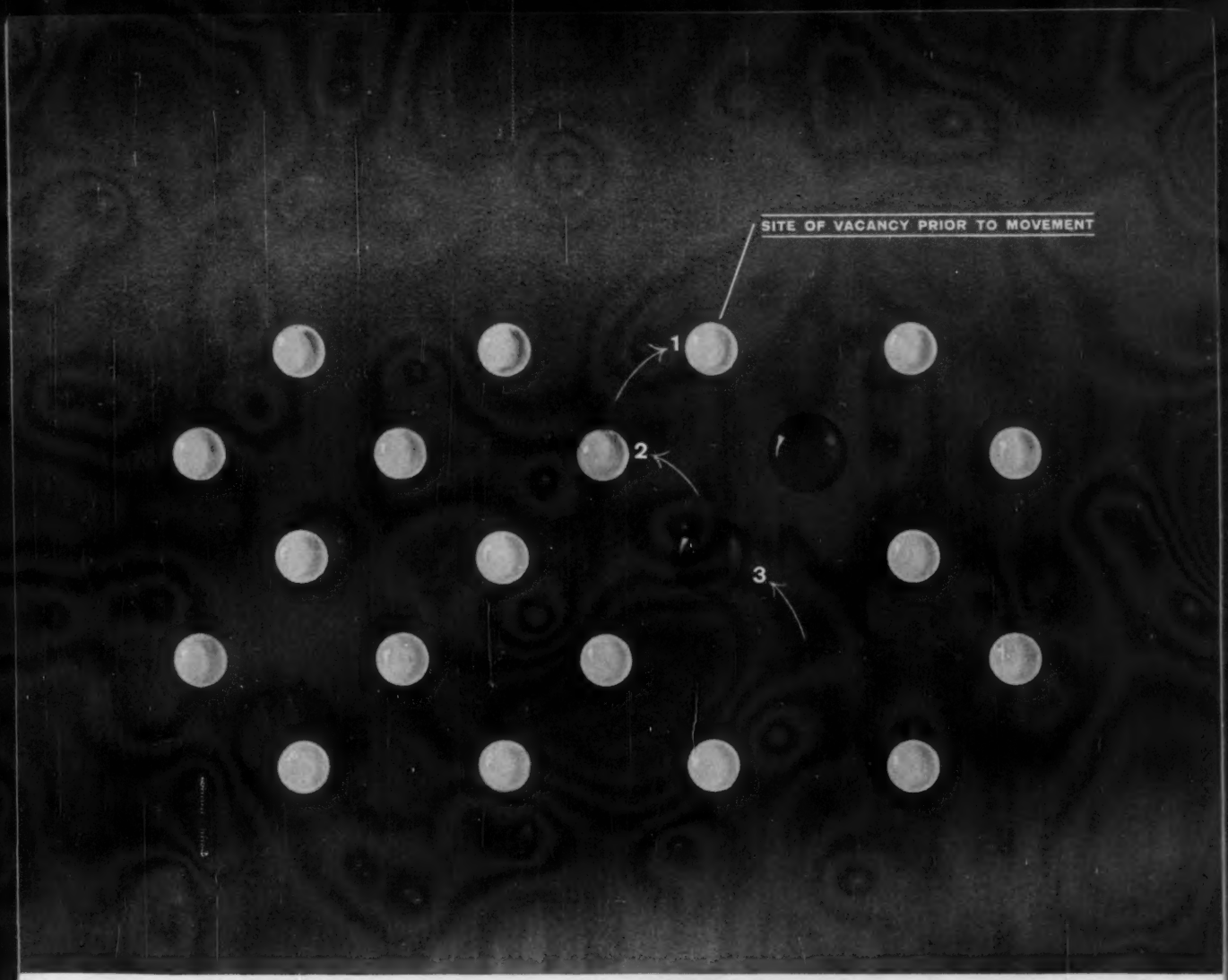
$$\left(V - \frac{\Delta V}{2}, V + \frac{\Delta V}{2}\right).$$

It has been shown that the function p'(V) defined as

$$p'(V) = \frac{1}{\Delta V} P\left(V - \frac{\Delta V}{2} < v \leqq V + \frac{\Delta V}{2}\right)$$

yields a good approximation to p(V) if $\triangle V$ can be assigned a value much less than the peak signal value.[1]

The measurement technique establishes a measure for p'(V). This is accomplished by generating a fixed-amplitude, rectangular pulse having a width equal to the time spent by the signal in the interval $\triangle V$ about V (Fig. 1A). A time average of the pulsed waveform will yield a d-c level which is a measure of $P\left(V - \frac{\Delta V}{2} < v \leqq V + \frac{\Delta V}{2}\right)$ but which, because $\triangle V$ is fixed, is also a measure of p'(V).



Report from IBM *Yorktown Research Center, New York*

HOW ATOMS JUMP IN SOLID SOLUTIONS

It is known that in many solid solutions, such as alpha brass, atomic rearrangement can be induced by an applied stress. Experiments of this nature have confirmed that the atomic mobility required for this rearrangement derives chiefly from the presence of lattice vacancies. A simple example is seen in the reorientation of a pair of solute atoms.

The time required for these atom jumps is under investigation by metallurgists at IBM Research.

By observing this rearrangement—a relaxation effect seen as a peak in a curve of internal friction vs. temperature—it is possible to measure atom mobility at temperatures far below those at which ordinary diffusion experiments can be carried out. It is also possible to freeze an excess of defects into the lattice of an alloy by quenching rapidly from high temperatures to produce an abnormally short relaxation time.

Through these experiments IBM scientists are determining how the equilibrium concentration and mobility of vacancies change with temperature. They seek to learn the manner in which the excess of vacancies retained after quenching disappears within the alloy.

IBM® RESEARCH

Investigate the many career opportunities available in exciting new fields at IBM.
International Business Machines Corporation, Dept. 554M3, 590 Madison Avenue, New York 22, New York.

Spectrometer for Basic Research

RELATIVE amounts and weights of atoms can be determined by a double-focusing mass spectrometer operating at the Argonne National Laboratory. The instrument can also measure the energy that holds the atomic nucleus together.

The spectrometer will be used by the Special Materials Division for research in nuclear chemistry and physics. It will sort atomic nuclei of different relative masses with greater accuracy than previously has been possible.

Operation

The machine is shaped like a backward letter *S* horizontal to the floor. A source of ions at one end is passed through the machine and they are sorted according to relative mass. At the other end a detector measures quantity of nuclei of each mass.

The source unit, one of four principal parts, charges and accelerates atoms into the machine. Velocity differences of the charged atomic nuclei are compensated in the electrostatic analyzer. The magnetic analyzer sorts nuclei according to weight, and the collector unit detects the ions.

A sample to be analyzed is introduced into the source unit and vaporized if it is not already a gas. An electron is removed forming positive ions that are accelerated into the machine.

The instrument transmits more than 95 percent of the ions produced in a conventional mass spectrometer ion source, with a resolution of 10,000. The largest conventional analytical mass spectrometer transmits from 1 to 10 percent of the ions, with a maximum resolution of 2,000.

A vacuum of 10^{-6} mm Hg is maintained throughout the spectrometer to allow unrestricted ion motion. The sample container can be introduced and removed without breaking the vacuum. In the source unit, the ions pass through electron-optical lenses that define beam width and divergence angle in two directions.

Analyzers

On leaving the source unit, the ions pass into the electrostatic analyzer, which is a 75-degree portion of a sphere with 100-inch radius. Each of its seven opaque fused-quartz sections is made up of two concentric electrode surfaces coated with gold.

The magnetic analyzer is a 14-ton permanent magnet with a field of 2,000 gauss. It has parallel poles describing a 110-degree section of a circle with 100-inch radius. The magnetic analyzer is mounted on a movable carriage to permit focusing.

Ions leave the source unit with slightly different velocities, fanning out in slightly different directions. The electrostatic analyzer spreads the ions in a parallel beam according to velocity and direction so that the magnetic analyzer can focus them, separated according to mass.

In the electrostatic analyzer, the ions pass within the walls of a curved passage formed by the gold-covered quartz sections. The inner (convex) wall bears a negative charge, and the outer (concave) wall carries a positive charge. Slower moving ions travel in paths with small radii, being attracted more to the inner wall.

The magnetic analyzer operates like the electrostatic unit except that the bending forces are dependent on mass rather than velocity. Ions with the least mass are pulled closest to the center of curvature.

The ion beam is focused according to mass at the collector unit. The heaviest ions are on one side, the lightest on the other. The electron multiplier that detects the ions can register a single ion.

Applications

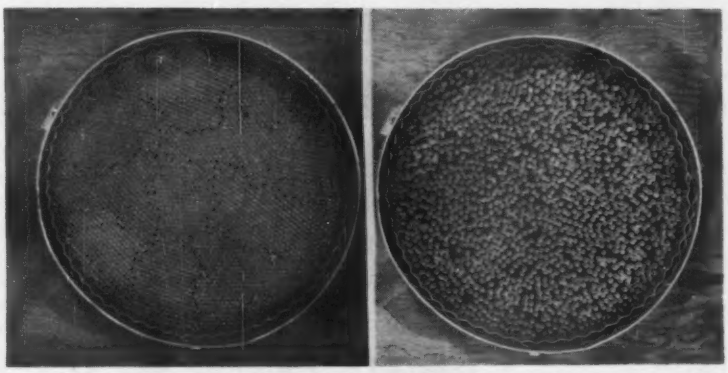
The new spectrometer will provide a series of chart-recorded peaks each representing sorted nuclei of a different mass. By measuring exact masses of nuclei, it will be possible to study amount of energy binding nuclei because energy has a mass equivalent.

The instrument will permit study of a variety of problems. For example, analysis of the isotopic composition of the small amount of uranium in a meteorite sample can be compared with the isotopic composition of uranium on the earth.

Also, a search can be made for curium-247, which has been found in the debris of a nuclear explosion. It is thought that this isotope may exist in minute amounts in nature.

Half-life of cesium-137 can be

Vibrator Simulates Atomic Motion

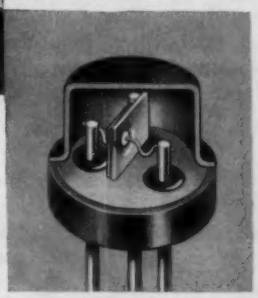


Vibrating platform at GE Research Lab keeps beads in constant random motion similar to atoms. Tightly packed beads show clear grain boundaries (left); loosely packed beads show atomic behavior in liquid (right)

CBS
NPN SWITCHING TRANSISTORS GIVE YOU
MISSILE RELIABILITY

Here Are Some of the Reasons Why . . .

Contamination is eliminated. Baking, surface treatment, electrical testing and package welding are all conducted in dry-boxes at a dewpoint temperature below −90°F.



Flat, even junctions avoid "hotspots." Precise control of time and temperature (±0.03%) of alloying process eliminates localized heating, gives long reliable life. Characteristics are more uniform.

Ruggedness exceeds MIL specification. Severe requirements for shock (1000 g, 1 ms), vibration (10 g, 100-3000 cps) and acceleration (20,000 g) are met by: electronic welding of formed lead wires, horizontal base tab, and welded JEDEC TO-9 case.

CBS NPN switching transistors have proved themselves in flight in many of our important "birds." They have been found to have the advantages of fast switching, high voltage, low cutoff current, and low saturation resistance. All 28 of these CBS transistors exceed the MIL-T-19500A specification.

This same proven reliability under the most adverse environmental conditions is yours for military or industrial core drivers, logic circuits or general switching functions. Write for complete data sheet E-353. Order from your local Manufacturers Warehousing Distributor.

Choose From . . .

2N306	2N357	2N388	2N439A	2N445	2N556	2N1000
2N312	2N358	2N438	2N440	2N446	2N634	2N1012
2N356	2N377	2N438A	2N440A	2N447	2N635	2N1090
2N356A	2N385	2N439	2N444	2N556	2N636	2N1091

More reliable products through Advanced Engineering

CBS semiconductors

CBS ELECTRONICS, Semiconductor Operations • A Division of Columbia Broadcasting System, Inc.

Sales Offices: *Lowell, Mass.*, 900 Chelmsford St., GLenview 4-0446 • *Newark, N. J.*, 231 Johnson Ave., TAlbert 4-2450 • *Melrose Park, Ill.*, 1990 N. Mannheim Rd., ESstebrook 9-2100 • *Los Angeles, Calif.*, 2120 S. Garfield Ave., RAymond 3-9081 • *Atlanta, Ga.*, Cary Chapman & Co., 672 Whitehall St., JAckson 4-7388 *Minneapolis, Minn.*, The Heimann Co., 1711 Hawthorne Ave., FEderal 2-5457 • *Toronto, Ont.*, Canadian General Electric Co., Ltd., LEnnox 4-6311

Now offering... creative careers in ordnance

Expanding operations in an exciting, growing company have created unusual career opportunities for ordnance engineers. Assignments on research and development projects will require the mature judgement of from two to ten years' experience in the field and present a combination of stimulating challenge and an ideal professional climate for contribution and personal development.

The company: the Crosley Division of Avco Corporation. There, confidence and personnel morale stem from aggressive management, a progressive approach to individual effort, and maximum support for all projects.

Definite creative career opportunities are available now. Experienced personnel can choose from:

- Ballistics
- Arming and Fuzing
- Non-nuclear Weapons Systems Analysis
- Target Damage Evaluation
- Warhead Design
- Shells System Design
- Microminiature Electronic Assemblies Design
- Projectile Design

For complete information, write or call: Mr. P. B. Olney, Manager of Scientific and Administrative Personnel Dept. E–150 Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio. Phone: KIrby 1-6600.

Avco / Crosley

measured more accurately. Cesium-137 is also a fission product. The spectrometer will extend investigations that have resulted in the first identification of isotopes such as plutonium-244, curium-247, curium-248 and californium-251. Each element can have a family of isotopes, each with a different mass because each has a different number of neutrons. Hydrogen, for example, has three isotopes.

Another analytical application will be to determine the kinds of atomic nuclei created when target atoms are bombarded by particles from a high-energy particle accelerator. The instrument will be used in this manner in conjunction with the zero gradient proton synchrotron now under construction at Argonne.

Apart from its analytical applications, the instrument will determine precisely the masses of species of atomic nuclei. Many species (nucleides) of medium and heavy atomic weights have not been precisely measured.

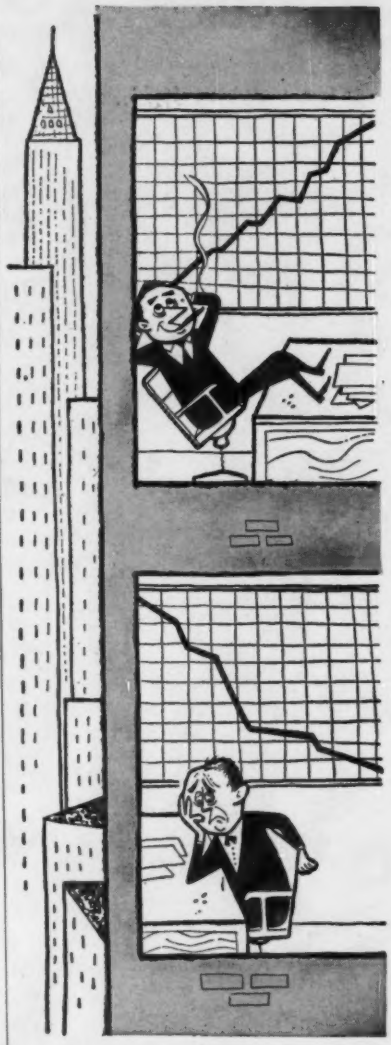
Simulator for Target Selection

RESEARCH program sponsored by the Army Signal Corps should enable air defense weapons systems to realize more fully their potentialities. The program, conducted by the National Bureau of Standards, involves development and implementation of rules for selecting best possible target among all in-range attackers.

Selection Problem

During an air attack, the enemy may delay recognition and accurate location of some attackers. Therefore, it is extremely important to make each shot most effective.

Factors involved in target selection include nearness and velocity of attacker. If all relevent criteria point to the same attacker, there is no selection problem. But such a simple situation rarely arises. A selection rule must combine relevant factors into a single composite criterion that yields an unambiguous choice of best target. Constructing a selection rule requires careful



WHO'S MAKING OUT BEST?

A quick, 3-minute Financial Roundup that names electronics companies that have achieved substantial financial gains. Tells where they are and what they make.

Fast visual summary of active stocks each week in the electronics industry. New public issues. Stock price averages.

This highly readable score card helps keep you informed on what counts most on the financial front. This is just one more reason why you should subscribe to electronics (or renew your subscription). Fill in box on Reader Service Card. Easy to use. Postage free.

FIND WHAT YOU NEED IN... electronics

analysis of the relationship between the various criteria, singly and collectively, and the objective of the defense.

Target selection would be simpler if each firing decision could be made with full foreknowledge of the future course of the air defense battle, which is obviously unattainable. Probabilistic prediction, though conceivably possible, would require extensive calculations incompatible with rapid decision making. Because the future of the battle can be treated only approximately, effectiveness of a proposed selection rule cannot readily be determined by theoretical means. Experiments are therefore performed in which a high-speed computer simulates a number of air defense battles and reports results of target selections.

Computer Simulation

An examination has been made of the general problem of conducting simulations as effectively as possible. The usual outputs of such studies are sufficient to indicate differences in effectiveness between two target selection rules, but cannot be used to detect the source of the difference. Methods for obtaining and presenting this more detailed information, which is necessary for the systematic improvement of selection rules, have been developed and are currently being automatized.

Another study, which dealt with computer functions common to most such simulation problems, suggested creation of a modular computer program so that different selection rules, defense systems and attack situations could be plugged in.

A prototype of such a program was prepared and is now in use. It performs standard simulator functions of moving attackers and defense missiles along their paths, umpiring hit or miss when a defense missile reaches its impact, determining when a target has carried out its mission and keeping a detailed record of all significant simulated events. Operation of this kind of a program has provided valuable information on possible use of computers to implement target selection rules.

Project Mercury, Wallops Island, Virginia

New Thrust for Industry in Tidewater Virginia

The recently developed National Aeronautics and Space Administration center at Wallops Island in Tidewater Virginia has opened vast new opportunities for the electronics industry. Manufacturers locating plants in the Tidewater area now have a triple advantage: (1) direct communications with NASA; (2) close proximity to decision-making bodies in Washington; (3) a centralized location within easy reach of other major electronic centers.

Electronic firms already located in Tidewater can testify to the productive advantages of the area . . . a ready supply of electronics technicians is available . . . a mild climate makes for maximum efficiency the year round . . . transportation facilities are excellent . . . and complete community cooperation is assured. If your company needs or is planning a new strategic location, consider Tidewater Virginia. For a confidential report geared to your specific requirements, contact:

Clarence H. Osthagen
Vice President and Executive Director

TVDC
TIDEWATER VIRGINIA

Tidewater Virginia Development Council

300 Boush Street Norfolk, Va.

Cesium Cell for Power Conversion

SUCCESSFUL CONVERSION of heat directly into alternating current electricity in significant amounts, without use of rotating machinery or d-c—a-c converter, was reported last week by scientists of General Dynamics Corporation's General Atomic Division.

Prior to this announcement, direct current had been obtained from experimental thermoelectric devices in several of the country's research laboratories, but scientists had been unable to produce an appreciable quantity of alternating current. The utility companies require alternating current for home and most industrial uses.

Scientists at General Atomic Division's John Jay Hopkins Laboratory for Pure and Applied Science in San Diego, Calif., used a high temperature cesium cell converter which produced sufficient alternating current to illuminate a series of small light bulbs. The cesium cell is one of several direct conversion methods under study.

Thermoelectric Research

Thermoelectric research, which has been underway since 1957, is partially supported by nine investor-owned utility companies of the western states. Eight of the companies are members of the Rocky Mountain-Pacific Nuclear Research Group. The other is the San Diego Gas and Electric Company.

Member companies of the Rocky Mountain-Pacific Group are: Arizona Public Service Company, California Electric Power Company, Pacific Power & Light Company, Portland General Electric Company, Public Service Company of Colorado, Public Service Company of New Mexico, Utah Power & Light Company, and Washington Water Power Company.

Frederic de Hoffman, senior vice president of General Dynamics Corporation and president of General Atomic Division said: "This discovery brightens the prospects that direct conversion equipment, including the cesium cell, may eventually be used in power plants instead of steam boilers, turbines and generators. It may prove possible to bring about reductions in both the capital and operating costs of electric power generation through the use of simpler and more compact equipment."

However, a great amount of research and development work lies ahead of us before we can begin to speak of large-scale commercial applications of direct conversion of heat into electricity.

The electric generating industry in the United States long ago generally abandoned the production of direct current power because alternating current—at high voltages—is required for efficient transmission. Direct current must be converted to alternating current before it has widespread commercial value.

Direct Conversion

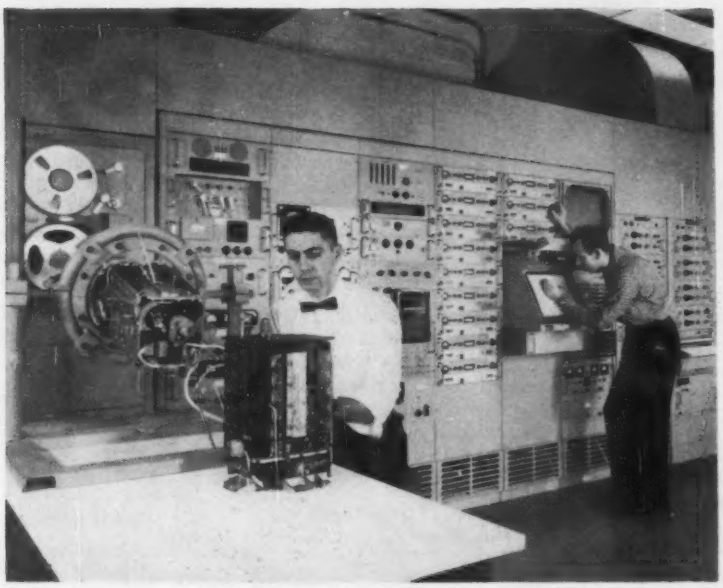
De Hoffman said General Dynamics has a particular interest in thermoelectric power because of the Corporation's leading role in the development of advanced, high temperature nuclear reactor systems.

"High temperature reactors are eminently suited to exploit the potential of high temperature thermoelectric direct conversion, as exhibited by the cesium cell," he explained.

The thermoelectricity program at General Atomic is under Robert W. Pidd, formerly professor of physics at the University of Michigan and one of the principal investigators in reactor tests in which heat produced by nuclear fission was directly converted into electricity for the first time.

Pidd said the alternating current produced in the cesium cell con-

Checking Out Subroc Components



Nine racks of six-foot high electronic equipment are used to complete a reliability checkout of a compact package of telemetering equipment developed by Goodyear Aircraft Corporation here for the Subroc antisubmarine weapon. The telemetering package, which is approximately 10 in. in dia. and 24 in. long, transmits 80 channels of test data. To checkout this capability, the test rack includes equipment requiring 100 signal lights, 550 vacuum tubes, 100 transistors, thousands of connections and 100 miles of wire. Shown working on the telemetering equipment is development engineer Donald T. Wight. At the chart recorder is Douglas Bohannon, an electronic instrument specialist.

THE MOST TAPE HANDLER FOR YOUR MONEY

HERE'S PROOF

The Potter 906 II, the high-speed digital magnetic tape handler that has come of age gives you higher performance, greater reliability and lower cost than any other tape handler on the market—bar none.

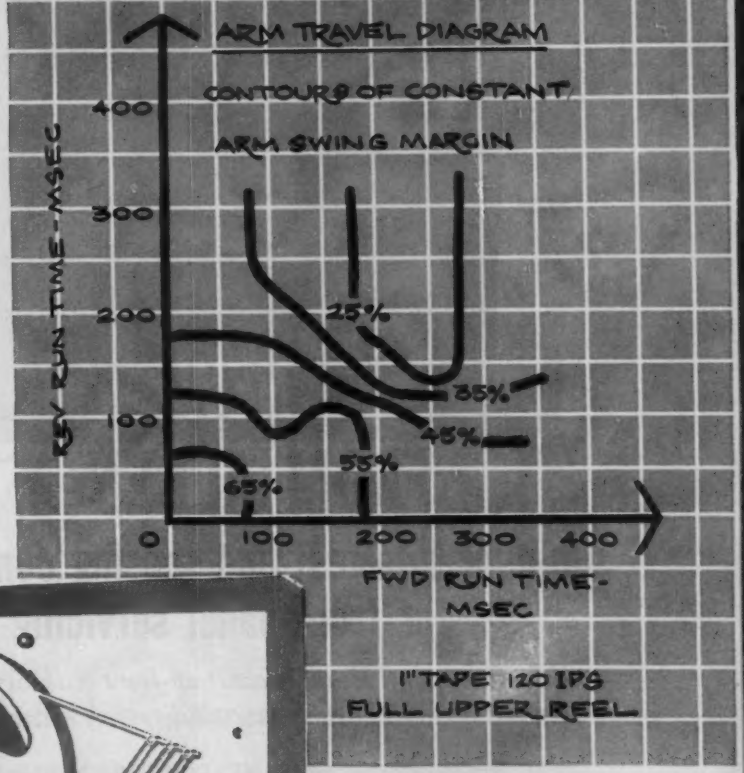
If you're interested in computer efficiency, you'll appreciate the kind of high performance shown by the actual test results plotted to the right. The Potter 906 II is the first and only tape transport to offer full forward-reverse cycling at 120 ips with 1" tape.

You'll be interested, too, in the other advantages that the 906 II now gives you for the first time. Among these are—

1. Low skew tape guide permits conventional recording at 400 bpi density.
2. Densities of 1500 bpi can be achieved by using this transport with the Potter Contiguous Double Transition system—450,000 8-bit characters per second on 1" tape.
3. Transistorized control of all functions simplifies computer design.
4. Simplified packaging for easy maintenance.
5. A price—far below other makes—that proves the economy of superior design.

Compare them any way you like—spec for spec, dollar for dollar, space for space—and you'll agree that the high-performance, low cost, Potter 906 II is the most tape transport at any price.

MODEL 906 II
Magnetic Tape Handler



Note the simplified packaging for accessibility and easy maintenance.

SPECIFICATIONS

TAPE SPEED
100 and 50 ips, standard. Maximum speed: 150 ips. Minimum speed: 1.0 ips.

START TIME
3 milliseconds or less.

STOP TIME
1.5 milliseconds or less.

STOP DISTANCE
0.100" ± .035" at 100 ips.

REWIND
300 ips constant speed either direction. 1¾ minutes for 2400 feet, millisecond start-stop, with 1/2" tape.

INTERCHANNEL TIME DISPLACEMENT
±2 microseconds at 100 ips from center clock to outside track on 1/2" tape.

COMPUTER INPUTS
All functions including speed selection, FWD, REV, FAST FWD, FAST REV, controlled with 0 volt "OFF," −3 volt "ON," level type signal. Other level or pulse control signals can be accommodated on special order.

BLOCK FEED REP RATE
200 blocks/second maximum.

TAPE TENSION
3 oz. nominal, 1/2" tape. Maximum tension in guide system, approximately 6 oz.

SIZE
24½" high swing-out panel for 19" rack mount. Hinge mounts separately for ease of installation.

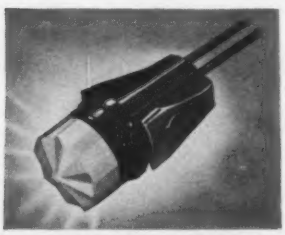
POTTER INSTRUMENT CO., INC. Potter **Sunnyside Boulevard, Plainview, L. I., N.Y.**
OVerbrook 1-3200

CIRCLE 79 ON READER SERVICE CARD

FROM ALDEN...

sub-miniature test and sensing components for front-panel servicing

Alden front-panel testing means: up-front visibility for easier monitoring — up-front accessibility for easier servicing.



1 **The Alden Pan-I-lite** — 3 times greater light efficiency · 1/6 the size of miniature bayonet bulbs · Quick and easy to replace from front end of panel · Visible from any angle, any distance · Non-refracting · No bulky focusing or refracting devices · Variety of colors and voltages (6v, 12v, 28v incandescent, and 110–220v Neon)

2 **The Alden Pan-I-lite switch** — a tiny push button indicator that gives positive indication — 180° visibility · One-piece, quickly replaceable bulb lens · Use as self-monitoring remote control switch for pulsing relays, solenoids, or as press-to-test indicator. In 6, 12, 28v incandescent blue, red, green, white, yellow · Quick snap-ring mount

3 **Alden Stak-in Test Jack** — Exclusive molded-in eyelet permits fast, low-cost machine assembly · Eliminates nuts, washers, sleeves · Won't vibrate loose, turn, or fall out · Rugged Nylon insulation · Reliable 360° Beryllium contact.

Send for free engineering samples today. Use your letterhead.

ALDEN PRODUCTS COMPANY
1127 N. Main Street, Brockton, Mass.

FROM ALDEN: A COMPLETE LINE OF FRONT-PANEL TEST AND SENSING DEVICES

verter is not in the conventional frequency range of 60 cycles but in the 100 kc range transmission.

Another aspect of the discovery which is the subject of further study is the fact that the cesium cell simultaneously produces both alternating and direct current.

The cesium cell is based on one of the oldest principles of electronics—the Edison effect. During his early experiments on the light bulb, Edison found that a white hot metal boils electrons out of its surface, much as water boils out of its surface when heated. This was the founding idea of all radio tubes in which electrons are boiled off hot wires and collected by an adjacent plate within the tube.

Boiled Electrons

In the cesium cell, a metal plate is heated white hot. The electrons boiled out of the hot plate, or emitter, are collected on an adjacent cold plate called a collector. The hot and cold plates act as the poles of a battery, delivering current to electric wires for distribution. Part of the heat put into the hot plate is converted directly into electric current.

A vapor of cesium metal, added in small amount to the cell, performs three functions which greatly enhance the direct conversion process: the vapor steps up the rate at which the electrons boil off the hot surface; it reduces the energy loss at the cold surface; and most important of all, it creates an ionized gas or plasma which neutralizes the electron space charge in the region between the hot and cold surfaces, thereby causing the current to pass more readily through the region.

The cesium cell can be made into practical shapes for incorporation into atomic power reactors.

Teflon Wire Coating Solves Corona Problem

FAILURE UNDER CORONA stress has been eliminated by a new Teflon-coated wire created by W. L. Gore & Associates, Inc., Newark, Delaware. This coating achieves corona resistance upwards of 70 times greater than Teflon-insulated hookup wire heretofore available.

The new development gives Tef-

lon about the same corona-stress resistance as the widely used silicone insulations; and where the latter are limited to about 200 C, Teflon withstands temperatures running more than 100 C higher.

Bouncing Ions

Corona begins with ionization resulting from increasing voltage stress. Teflon, like all insulations, normally contains microvoids at the coating-wire interface. Ions formed by high voltage stresses are bounced around in these minute cavities by an alternating current. When they bombard the surfaces containing them, this generates heat—and the combined effects of heat and impact begin enlarging the cavities.

The result is a runaway reaction. Temperature and extent of ionization increase as the cavities grow, until the ions finally break through the insulation.

Aircraft and missile wiring is especially prone to this kind of failure, because the corona initiation level drops as atmospheric pressure decreases. As an example, corona stress may begin at about 2,000 volts in a typical 10-mil insulation at sea level; but at high altitude, or in outer space, the initiation level might be reached at less than half this voltage.

Once corona is initiated, there's an added factor: extinction voltage —that is, the point to which deterioration will continue—may be 500 volts lower than the initiation level. Teflon has been quite susceptible to corona stress. And, while there have been other materials with far better corona resistance, none of these have Teflon's electrical properties and heat resistance.

The new Teflon wire covering, Type CR, is based on two elements: a special formulation compounded to minimize corona initiation and prevent cavity growth; and manufacturing techniques which apply the Teflon in a homogeneous, essentially void-free wire covering.

The development is marketed as MONO-TET CR single-conductor wire in sizes from AWG 28 to 0; it comes in 10 basic colors and with stripes. It's also available in shielded and coaxial conductors, and as MULTI-TET CR in ribbon cable.

NOW DROP TUR[illegible]

FLASH – INDEPENDENT LAB TESTS PROVE 7 & 9 PIN SIZES EXCEED REQUIREMENTS MIL-19786A (NAVY)

[illegible]ERATURES AS MUCH AS 130°C

prolong tube life—increase reliability

atlee FULL-CONTACT TUBE COOLING SHIELDS provide MAXIMUM tube cooling through

- **FULL CONTACT** *with tube*
- **FULL CONTACT** *with shield*
- **FULL CONTACT** *with chassis*

The new **atlee** FULL-CONTACT tube-cooling shield, with exclusive "delta-wave" ≤Z≤Z≤Z insert and flat-mounting shield base, provides a spectacular reduction of envelope temperatures even under extreme operating conditions. Tests prove a drop of 130°C below bare-bulb temperatures, and 80°C below levels reached with JAN shields and standard N.E.L. inserts.

Here is a significant advance in the fight against equipment failure even under conservative operating conditions. Further, where tubes must operate close to maximum ratings, it means a real reduction in the inevitable penalty of shorter tube life.

DESIGN FOR RELIABILITY WITH **atlee** *—a complete line of dependable heat-dissipating holders and shields of all types, plus the experience and skill to help you solve unusual problems of holding and cooling electronic components.*

Get the complete story in your free copy of this fact-filled Bulletin!

atlee corporation
(Formerly Atlas E-E Corporation)
47 PROSPECT STREET, WOBURN, MASSACHUSETTS

CIRCLE 81 ON READER SERVICE CARD

Develop Strippable P-C Negatives

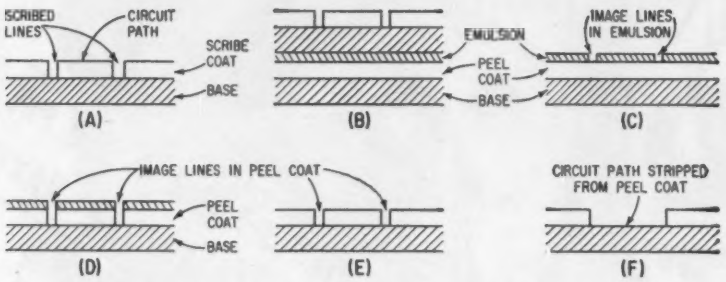
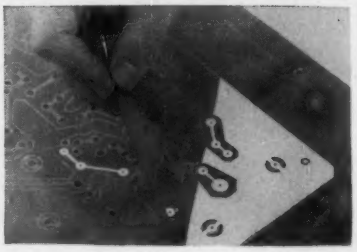


FIG. 1—Steps in production of scribed master and printed wiring negatives



Peel-coat is pulled off after photographic processing. Technique also eliminates opaquing of large areas

PRINTED CIRCUIT layouts and negatives made by a method combining film scribing and photographic techniques are reported to offer improvements in accuracy and design flexibility, while reducing drafting time and expense.

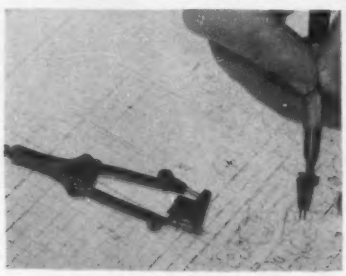
Techniques were developed by General Electric Company's Heavy Military Electronics Department, Syracuse, N. Y., in cooperation with the Keuffel and Esser Co., Hoboken, N. J. K & E supplies the Mylar-base film (Stabilene) with a strippable coating on which the layouts are made.

Masters are produced by a method similar to that previously reported (ELECTRONICS, p 62, August 29, 1958). However, as shown in Fig. 1, the circuit path is not peeled from between the scribed lines.

Negatives used to print the circuit boards are produced in six steps. The outline of the circuit paths are scribed on scribe-coat film master (Fig. 1A). Peel-coat film is exposed to the master (Fig. 1B), producing a line image in the photo emulsion layer of the peel-coat film. The master can then be filed or further reprinted.

Image lines in the photo emulsion are removed by developing (Fig. 1C). The film is wiped with an alcohol-dampened cloth, dissolving the image lines down to the Mylar base (Fig. 1D). Photo emulsion is washed off in a Clorox bath (Fig. 1E). The peel coat between the lines is peeled off, leaving finished circuit paths (Fig. 1F). The remaining peel coat acts as a photographic resist during board printing.

The tools used to scribe the circuit path and land outlines are made with steel alloy points in graduated widths. They are equipped with spring-type shock absorbers to maintain accuracy on curved lines. Changes in the patterns can be made with touch-up fluids on the master, peel-coat negative or final pattern.



Original drafting layout is made on master film containing grid lines. Scribers outline circuit paths and connection pads

Plastic Skin Packages Components

Six wiring harnesses are positioned for packaging. Loading bed is slid under film at left

SKIN PACKAGING, which has been primarily used by the consumer goods industries, can also be used to package electronic components, wire and circuit board assemblies and electromechanical parts, according to Print-A-Tube Company, Paterson, N. J.

The parts illustrated were packaged on machinery made by the firm's Skin-Pak Machinery Co., Division. The skin is Mylar extruded

RHEEM / SILICON MESA TRANSISTORS

2N696 - 2N697

Utmost versatility, maximum reliability,
25 millimicrosecond switching, 5 ohm
saturation resistance, 2 watt dissipation

PRODUCTION QUANTITIES FROM STOCK

Rheem

RHEEM SEMICONDUCTOR CORPORATION
A SUBSIDIARY OF RHEEM MANUFACTURING COMPANY
Dept. A1, P. O. Box 1327, Mountain View, California • YOrkshire 8-8391
Eastern Regional Office: 610 E. Palisade Ave., Englewood, N. J. • LOwell 7-4336
6257

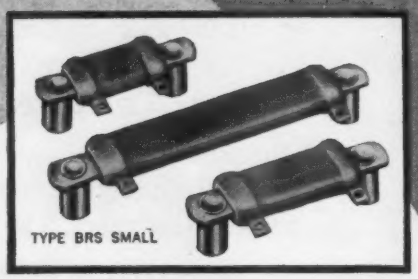
Space Problem?

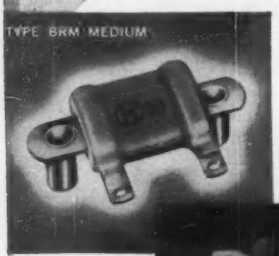
SPECIFY Blue Ribbon

PRECISION SPACE-SAVER

RESISTORS

. . . the Complete Line of Flat and Stack Mounting Wire Wound, Power Resistors





Available in Wattage Ratings from 10 to 75 W
Resistance Range from .10 to 100,000 Ohms

These High Reliability Space-savers feature matched coefficient of expansion with gray vitreous enamel covering for complete protection from overloads and environmental conditions. Aluminum thru-bracket improves heat dissipation, minimizes hot spots, allows a higher wattage rating per unit of space. Bracket construction facilitates stacking and saves additional space.

For Complete Specifications and illustrated bulletin on H-H Blue Ribbon Resistors, call or write, today!

'Gray Line' RHEOSTATS

Complete range from 25 to 1000 watts. Shock resistant construction. High temperature enamel bonding withstands greater overload.

'Gray Line' RESISTORS

Fixed, adjustable, ferrule and axial lead types for all commercial and military applications. Super-ruggedized for complete reliability.

The Mark of Quality since 1924

HARDWICK, HINDLE · INC

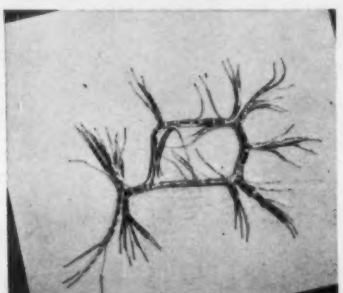
40 HERMON ST., NEWARK 5, NEW JERSEY

over polyethylene. Foil, paper, Saran or other materials may be included in the laminate, depending on strength or permeability required and temperature sensitivity of the parts packaged.

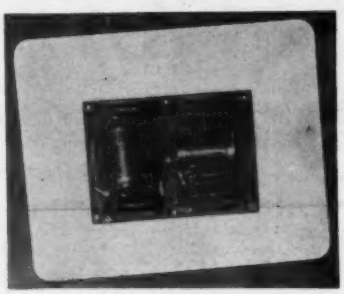
Parts are placed on a sheet of uncoated cardboard about 0.030 inch minimum thickness, laid in the loading bed. Film drawn from a roll is heated for 8 to 10 seconds to soften the polyethylene. A vacuum is then drawn under the film for 5 to 6 seconds, draping the film over the parts and sealing the polyethylene to the cardboard. The master card is cut into individual packages or strips.

Minimum film thickness is 1 mil. Heavier films are better for tightly conforming films since their added strength allows more stretching

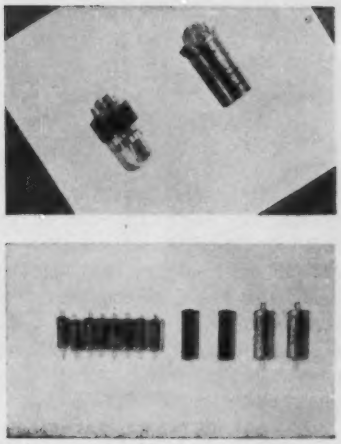
As package is removed from machine, fresh film is drawn into position



Finished harness package



Packaged circuit board



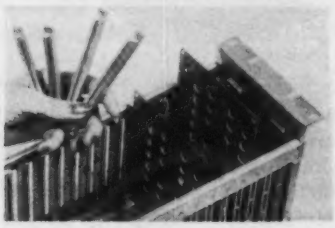
Relays and axial-lead components

and draping by lengthening the vacuum cycle.

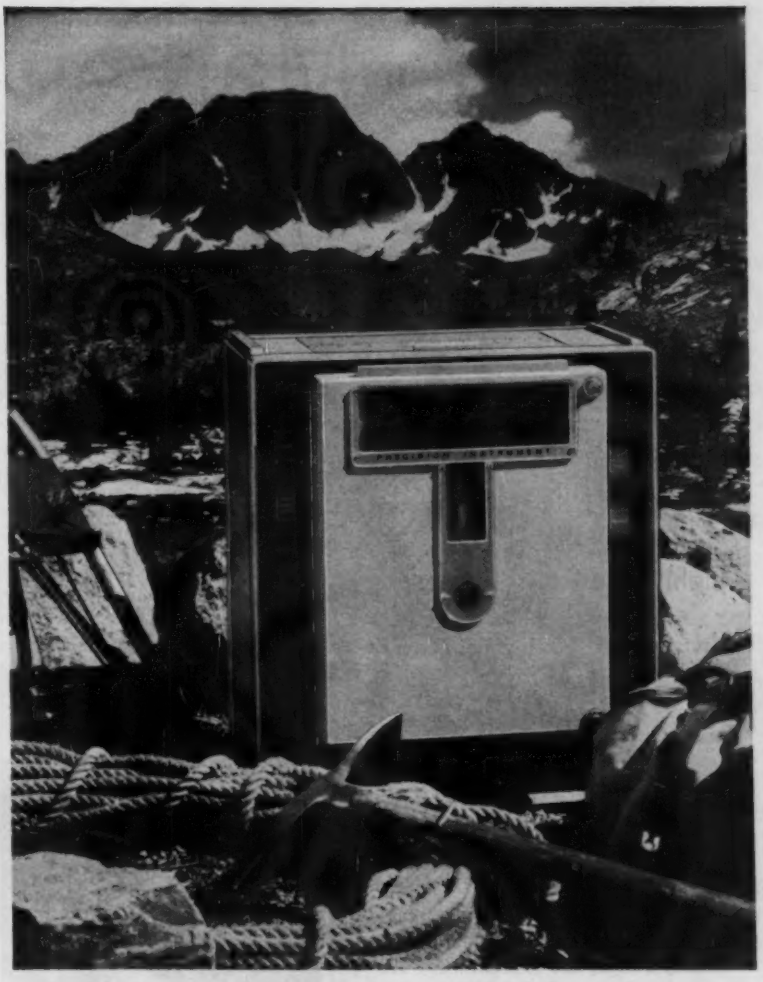
Large parts are generally hand-positioned on the cardboard. Small parts can be scattered over the board. If a regular arrangement is desired, a cutout can be placed over the cardboard, the parts scattered so they fall in the depressions, and the cutout lifted off before film is applied. The backing can also be die-cut to receive odd-shaped parts, such as transistors.

The fusing temperature is generally below 240 F, the melting point of the polyethylene. The woven wire heater plate can be provided with shields to protect temperature-sensitive parts or prevent the polyethylene from adhering to the parts. The sheet strips off in a single piece because of the air gap around the packaged parts.

Circuit Card Holders



HOLDERS for rack-mounted printed circuit cards are being molded of plastic by Space Products Co., North Long Beach, Calif. The material used is a high-impact plastic (Koppers Dylene 800) which resists bowing.



CARRY A PI RECORDER *anywhere!*

Now you can record test data on-the-spot. In both lab and field you get accuracies equal to or better than big, rack mounted units. Just pick up and move a multi-channel (up to 14) PI tape recorder/reproducer as you would any other item of test equipment.

Instead of 1,000-lb. cabinets, requiring 1000 watts, you're working with recorders 10 times smaller and lighter, using 250 watts or less.

In the field, you get laboratory performance under the most difficult environments. PI fits many places where 19-inch racks won't go. One man can carry a rugged PI recorder to virtually any test site.

How did PI put precision in a small package? By combining transistorized electronics with unique stacked reel tape magazines. PI recorders use standard tapes and heads, are compatible in every way with standard recording practices and other recording equipment.

May we suggest you call your PI representative to arrange a demonstration? If you are uncertain who he is, please write direct. Address Dept. 181-A.

Precision Is Portable

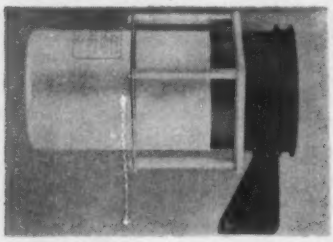
PRECISION INSTRUMENT COMPANY

1011 COMMERCIAL STREET • SAN CARLOS, CALIFORNIA • PHONE: LYTELL 1-4441

5

CIRCLE 85 ON READER SERVICE CARD 85

On The Market



Diameter Equalizer for disk recording

CINEMA ENGINEERING DIVISION, 1100 Chestnut St., Burbank, Calif. New stereo unit is effectively a dual equalizer that provides automatic compensation for losses in high frequencies. H-f losses are corrected continuously between the 5 in. and the 12 in. diameter point, maximum equalization being 8 db at 10 kc. Unit is mounted directly on the recording machine and attached by the spring drive to the recording head carriage. Dimensions are 3⅜ in. in diameter; 6¾ in. long; mounting bracket extends 2 in. with net weight of 2½ lb.

CIRCLE 301 ON READER SERVICE CARD

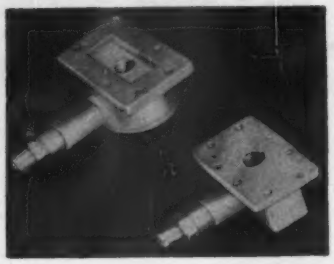
Tachometer highly sensitive

AIRPAX ELECTRONICS INC., Seminole Division, Fort Lauderdale, Fla. The Tach-Pak completely self-contained tachometer has an accuracy of better than 0.25 percent. RPM measurement is accomplished with no mechanical or electrical linkage between this tachometer and any rotating system component. Transistor and magnetic circuits convert a signal input from a magnetic pickup into a current output which can be indicated on any 0-1 ma average reading device. Power requirement is less than a watt and the source may be a 60 or 400 cps a-c line or 12 v battery.

CIRCLE 302 ON READER SERVICE CARD

Microwave Cavities cast invar

PORTCHESTER INSTRUMENT CORP., 114 Wilkins Ave., Port Chester, N. Y. A series of cast invar cavities, tunable over a 10 percent frequency range, are available for frequencies from 5,925-7,750 mc, and



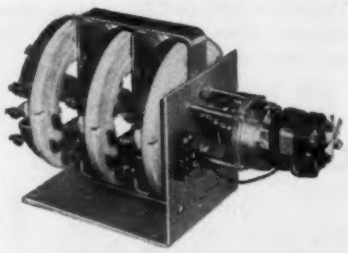
can be designed in frequencies from L band through Ku band. The cavities, when used with a waveguide discriminator, are capable of controlling the frequency of transmitting klystrons to conform to FCC specs. The technique of invar casting and glass sealing has reduced the price considerably.

CIRCLE 303 ON READER SERVICE CARD

Motorized Rheostats for remote control

OHMITE MFG. CO., 3677 Howard St., Skokie, Ill., can now supply complete motor-driven rheostats or variable transformers. Such units are employed in remote control applications or where a predetermined rate of resistance or voltage change must be smoothly achieved. Standard drives consist of a motor with integral gear reducer, and cam-operated limit switches to accomplish reversal of the control. Standard assemblies are arranged for horizontal surface mounting but assemblies for vertical mounting may be provided.

CIRCLE 304 ON READER SERVICE CARD



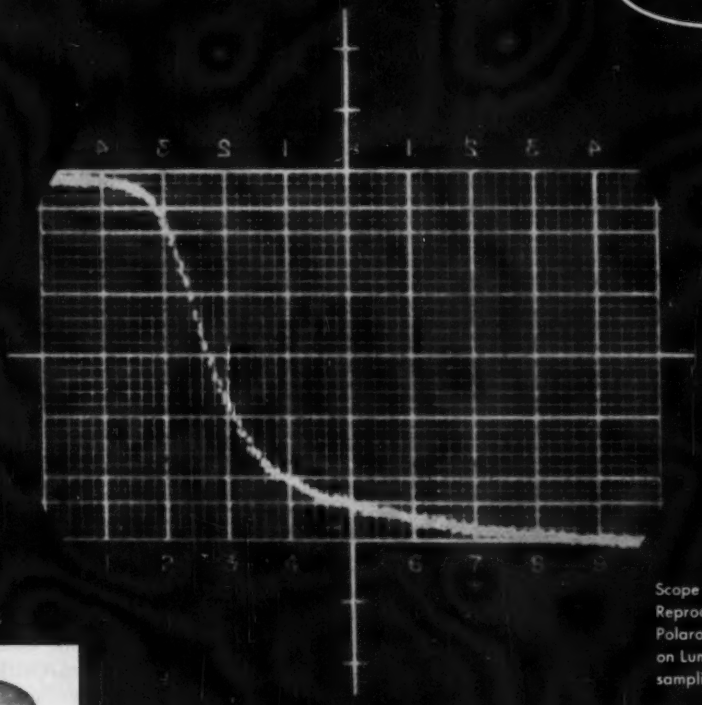
Micro-module Wafers hard and tough

CORNING GLASS WORKS, Corning, N. Y., has available Fotoceram micro-module wafers which are produced by chemically machining glass to "micro accuracy" from a photographic reduction, then converting it to a ceramic. The wafers are nonporous, dimensionally stable, and shock resistant. Company says that designs other than four patterns in stock can be produced economically in a matter of days. Further information may be readily obtained by writing on company letterhead.

Tiny Terminals compression seal

THE SPHERE CO., INC., 25 Amity St., Little Falls, N. J. Subminiature compression seal terminals (nine on an AF cover) are 11/64 in. in diameter and vary from 11/64 in. to ¼ in. in height, depending on head style. They are made with an L-3 Steatite,

ANOTHER FIRST FROM RAYTHEON



Scope shows millimicroseconds! Reproduced from unretouched Polaroid photograph of trace on Lumatron Model 12AB sampling oscilloscope.

New Avalanche Mode Silicon Transistor Switches in 2½ milli-μsec!

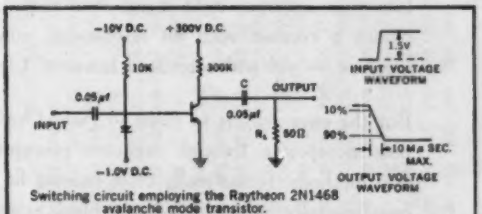
FASTEST SWITCHING! The new Raytheon 2N1468 silicon NPN transistor, designed for avalanche mode operation, has a *guaranteed* switching time of 10 millimicroseconds maximum when used in the circuit shown. Speeds faster than 1½ millimicroseconds are feasible.

HANDLES 40 WATTS! The new Raytheon avalanche mode transistor is capable of switching 40 watts peak power. Average power dissipation is 250 milliwatts.

HIGH TEMPERATURE! Silicon – the maximum operating temperature of the new Raytheon 2N1468 is 125°C.

PATENTED! Protected by U.S. Patent No. 2,843,515 (covering junction transistors exhibiting current amplification of at least unity when operated in the avalanche breakdown region), this revolutionary new transistor is a Raytheon exclusive.

AVAILABLE NOW! Production quantities of this new Raytheon 2N1468 are available *now* for your evaluation. For data sheets and other technical information, contact your nearest Raytheon office.



Switching circuit employing the Raytheon 2N1468 avalanche mode transistor.

CHARACTERISTICS OF 2N1468 AT 25°C.
Thermal Dissipation Coefficient (in air) $K_\theta = 0.5°C/mw.$

	Min.	Avg.	Max.	Units
Avalanche Voltage	40	70	–	Vdc
Emitter Cutoff Current V_{EB}-10V	–	–	1.0	μAdc
Switching Time in Circuit	–	2.5	10.0	mμsec.
Peak Collector Current	–	–	2	A max.
Junction Operating Temperature	–	–	125	°C max.

Your local authorized Raytheon Distributors carry in-stock inventories for immediate delivery.

RAYTHEON SEMICONDUCTOR DIVISION RAYTHEON COMPANY

SILICON AND GERMANIUM DIODES AND TRANSISTORS • SILICON RECTIFIERS • CIRCUIT-PAKS

NEW YORK, PLaza 9-3900 • **BOSTON**, Hillcrest 4-6700 • **CHICAGO**, National 5-4000 • **LOS ANGELES**, NOrmandy 5-4221
ORLANDO, GArden 3-1553 • **SYRACUSE**, GRanite 2-7751 • **BALTIMORE**, SOuthfield 1-0450 • **CLEVELAND**, Winton 1-7716 • **SAN FRANCISCO**, Fireside 1-7711
CANADA: Waterloo, Ont., SHerwood 5-6831 • **GOVERNMENT RELATIONS**: Washington, D.C., METropolitan 8-5205

-and now the vibration test!

Shock — testing on the rocks? If vibration and shock are *your* headache, you *could* build your *own* pots to lick this problem! But look out for foul play in the shaft and bushings, under shock — you can lose your accuracy right *there!* And make sure your pet design includes a contact with no resonances, minimum mass, low wiper pressure — yet with excellent linearity! Oh, you'll be plenty busy!

But the *easy* way is to come to Ace! Our shockless pots incorporate, through exclusive precision production methods, fantastically close bearing fit. And our own specially balanced contacts place extremely low mass at the edge-wipe end, under low brush pressure, for steady contact under shock. Tempered precious metals and low contact resistance mean long, corrosion-free wear. Tested to 50 G's at 2000 cycles.

Our complete pot line incorporates all these anti-shock design features. Under extreme servo applications, this ½" servo-mount Series 500 Acepot delivers 0.3% linearity.

See us at WESCON
Booth 3414

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
SOmerset 6-5130 TMX SMVL 181 West. Union WUX

Acepot® Acetrim® Aceset® Aceohm® *Reg. Appl. for

88 CIRCLE 88 ON READER SERVICE CARD

meeting JAN-1-10 specs. Head styles available are: notched lug, turret head, hollow turret, and lug with hole. They are supplied with a Neoprene, or Silicone seal. Covers can be drop shipped to Sphere for the assembly of terminals in the pattern of the customer's choice. Prices are as low as $77/M assembled to covers.

CIRCLE 305 ON READER SERVICE CARD

Portable Recorder 6-in. chart

SYSTRON CORP., 950 Galindo St., Concord, Calif., has developed a line of potentiometer recorders for applications such as strain gage or thermocouple monitoring. New optional features include ball point pen, 1 mv span preamp, and resistance bulb bridge for temperature measurements. Units are available for either portable or rack mounting use. With selectable 9 to 120 mv span, gear shift selection of chart speeds, 0.8 sec balance time, and ¼ percent sensitivity, the units provide extreme versatility.

CIRCLE 306 ON READER SERVICE CARD

Commutator eliminates preamps

RADIATION INC., P. O. Box 37, Melbourne, Fla. The Radiplex answers the need for high-speed electronic sampling of low-level signals. Basic unit contains 50 diode gates which sequentially connect the inputs to

electronics READER SERVICE

Use these handy prepaid
READER SERVICE POST CARDS
for more detailed information on:
PRODUCTS ADVERTISED
NEW PRODUCTS "On the Market"
LITERATURE of the WEEK

Circle the number on the READER SERVICE post card at the right that corresponds to the number at the bottom of Advertisement, New Product item, or the Literature of the Week selection in which you are interested.
Please print clearly. All written information must be legible in order to be efficiently processed.

ALL FOREIGN INQUIRIES that cannot reach **electronics** before the expiration dates noted on the Reader Service Post card, must be mailed directly to the manufacturer.

TO SUBSCRIBE TO OR TO RENEW electronics — Fill in the "For Subscriptions" area on the card if you desire to subscribe to or renew your present subscription to **electronics.** Send no money. **electronics** will bill you at the address indicated on the Reader Service post card.

***MULTI-PRODUCT ADVERTISEMENTS —**
For information on specific items in multi-product advertisements note area marked by asterisk (*) on post card. Print circle number of advertisement and name of product(s) in which you are interested.

Name _____ Title _____

Company _____

Address _____

INSIDE FRONT COVER																														INSIDE BACK COVER
1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	321	341	361	381	401	421	441	461	481	501	521	541	561	581	601
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	322	342	362	382	402	422	442	462	482	502	522	542	562	582	602
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	323	343	363	383	403	423	443	463	483	503	523	543	563	583	603
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	324	344	364	384	404	424	444	464	484	504	524	544	564	584	604
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	325	345	365	385	405	425	445	465	485	505	525	545	565	585	605
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	326	346	366	386	406	426	446	466	486	506	526	546	566	586	606
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	327	347	367	387	407	427	447	467	487	507	527	547	567	587	607
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	328	348	368	388	408	428	448	468	488	508	528	548	568	588	608
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	329	349	369	389	409	429	449	469	489	509	529	549	569	589	609
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	330	350	370	390	410	430	450	470	490	510	530	550	570	590	610
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	331	351	371	391	411	431	451	471	491	511	531	551	571	591	611
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	332	352	372	392	412	432	452	472	492	512	532	552	572	592	612
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	333	353	373	393	413	433	453	473	493	513	533	553	573	593	613
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	334	354	374	394	414	434	454	474	494	514	534	554	574	594	614
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	335	355	375	395	415	435	455	475	495	515	535	555	575	595	615
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296	316	336	356	376	396	416	436	456	476	496	516	536	556	576	596	616
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297	317	337	357	377	397	417	437	457	477	497	517	537	557	577	597	617
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298	318	338	358	378	398	418	438	458	478	498	518	538	558	578	598	618
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299	319	339	359	379	399	419	439	459	479	499	519	539	559	579	599	619
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600	620

JAN. 29 • 60
Card Expires
MAR. 29 • 60
For Foreign Mailings
MAR. 19 • 60

FOR SUBSCRIPTIONS
Check One Box

☐ New
☐ Renewal

Check One Box Below

DOMESTIC
☐ 3 yrs.-$12.00
☐ 1 year-$ 6.00

CANADA
☐ 1 year-$10.00

FOREIGN
☐ 1 year-$20.00

Product(s) M'f'd _____

Service(s) _____

* Circle No.	Product	Circle No.	Product
____	_____	____	_____
____	_____	____	_____
____	_____	____	_____

Searchlight Section

460	463	466	469	472	475	478
461	464	467	470	473	476	479
462	465	468	471	474	477	

Name _____ Title _____

Company _____

Address _____

INSIDE FRONT COVER 1 21 41 61 81 101 121 141 161 181 201 221 241 261 281 301 321 341 361 381 401 421 441 461 481 501 521 541 561 581 601 2 22 42 62 82 102 122 142 162 182 202 222 242 262 282 302 322 342 362 382 402 422 442 462 482 502 522 542 562 582 602 3 23 43 63 83 103 123 143 163 183 203 223 243 263 283 303 323 343 363 383 403 423 443 463 483 503 523 543 563 583 603 4 24 44 64 84 104 124 144 164 184 204 224 244 264 284 304 324 344 364 384 404 424 444 464 484 504 524 544 564 584 604 5 25 45 65 85 105 125 145 165 185 205 225 245 265 285 305 325 345 365 385 405 425 445 465 485 505 525 545 565 585 605 6 26 46 66 86 106 126 146 166 186 206 226 246 266 286 306 326 346 366 386 406 426 446 466 486 506 526 546 566 586 606 7 27 47 67 87 107 127 147 167 187 207 227 247 267 287 307 327 347 367 387 407 427 447 467 487 507 527 547 567 587 607 8 28 48 68 88 108 128 148 168 188 208 228 248 268 288 308 328 348 368 388 408 428 448 468 488 508 528 548 568 588 608 9 29 49 69 89 109 129 149 169 189 209 229 249 269 289 309 329 349 369 389 409 429 449 469 489 509 529 549 569 589 609 10 30 50 70 90 110 130 150 170 190 210 230 250 270 290 310 330 350 370 390 410 430 450 470 490 510 530 550 570 590 610 11 31 51 71 91 111 131 151 171 191 211 231 251 271 291 311 331 351 371 391 411 431 451 471 491 511 531 551 571 591 611 12 32 52 72 92 112 132 152 172 192 212 232 252 272 292 312 332 352 372 392 412 432 452 472 492 512 532 552 572 592 612 13 33 53 73 93 113 133 153 173 193 213 233 253 273 293 313 333 353 373 393 413 433 453 473 493 513 533 553 573 593 613 14 34 54 74 94 114 134 154 174 194 214 234 254 274 294 314 334 354 374 394 414 434 454 474 494 514 534 554 574 594 614 15 35 55 75 95 115 135 155 175 195 215 235 255 275 295 315 335 355 375 395 415 435 455 475 495 515 535 555 575 595 615 16 36 56 76 96 116 136 156 176 196 216 236 256 276 296 316 336 356 376 396 416 436 456 476 496 516 536 556 576 596 616 17 37 57 77 97 117 137 157 177 197 217 237 257 277 297 317 337 357 377 397 417 437 457 477 497 517 537 557 577 597 617 18 38 58 78 98 118 138 158 178 198 218 238 258 278 298 318 338 358 378 398 418 438 458 478 498 518 538 558 578 598 618 19 39 59 79 99 119 139 159 179 199 219 239 259 279 299 319 339 359 379 399 419 439 459 479 499 519 539 559 579 599 619 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540 560 580 600 620

JAN. 29 • 60
Card Expires
MAR. 29 • 60
For Foreign Mailings
MAR. 19 • 60

FOR SUBSCRIPTIONS
Check One Box

☐ New
☐ Renewal

Check One Box Below

DOMESTIC
☐ 3 yrs.-$12.00
☐ 1 year-$ 6.00

CANADA
☐ 1 year-$10.00

FOREIGN
☐ 1 year-$20.00

Product(s) M'f'd _____

Service(s) _____

* Circle No. Product Circle No. Product

Searchlight Section
460 463 466 469 472 475 478
461 464 467 470 473 476 479
462 465 468 471 474 477

FIRST CLASS
PERMIT NO. 64
(SEC. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

6¢ Postage Will Be Paid By
electronics
Reader Service Dept.
330 West 42nd Street
New York 36, N. Y.

FIRST CLASS
PERMIT NO. 64
(SEC. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

6¢ Postage Will Be Paid By
electronics
Reader Service Dept.
330 West 42nd Street
New York 36, N. Y.

THE ELECTRONICS MAN... A SPECIAL BREED

In most industries the management man went to business school and doesn't concern himself with design problems.

In most industries the design engineer doesn't concern himself with management problems.

The electronics man is different.

He is many things. He is in Research-Design-Production-Management. His interests are in any or all of the four areas.

No matter where you find the electronics man his engineering background enables him to influence the purchase of electronic components and equipment. Your advertising must reach him if you are to sell electronic goods.

This is the strength of **electronics**, the one magazine published weekly and edited to reach this engineering oriented electronics man, wherever he is.

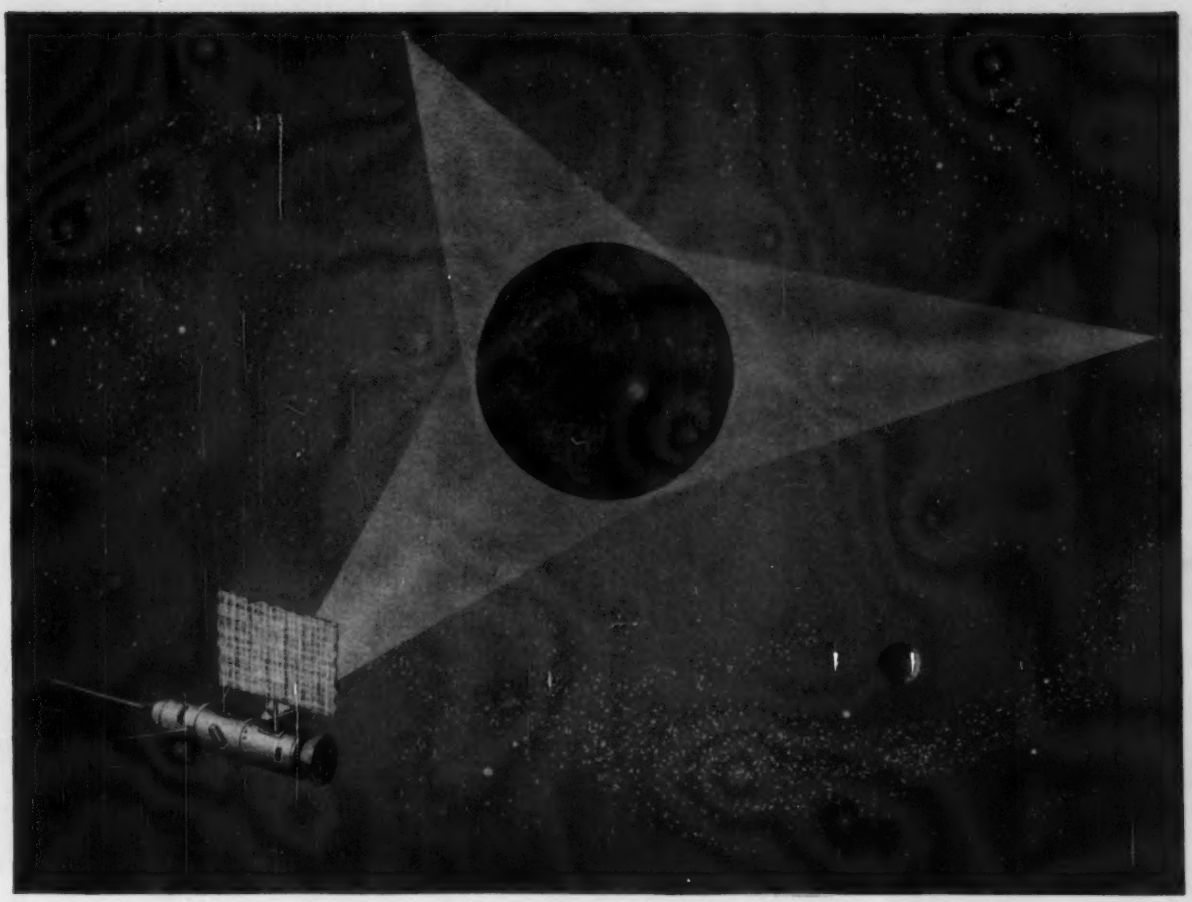
THE ELECTRONICS MAN
"BUYS" WHAT HE READS IN...

electronics

and in the

electronics BUYERS' GUIDE

A McGRAW-HILL PUBLICATION
330 West 42nd St., N.Y. 36, N.Y.



THE FAR REACHES OF MAN'S KNOWLEDGE

Over the years ITT Laboratories has made significant contribution to advancing the state of the art in electronics. Today highly evolutionary progress is moving apace in such areas as broadband communications systems, low-noise parametric amplifiers, atomic clocks, inertial navigation systems, high density storage tubes, and space guidance, navigation and flight control. Major achievements are resulting in stored program digital computers and digital communications.

While engineers and scientists at ITT Labs meet the urgencies of today, they are simultaneously exploring the far reaches of man's knowledge, accepting small failures, making small successes, to unlock the doors to revolutionary achievements in electronics.

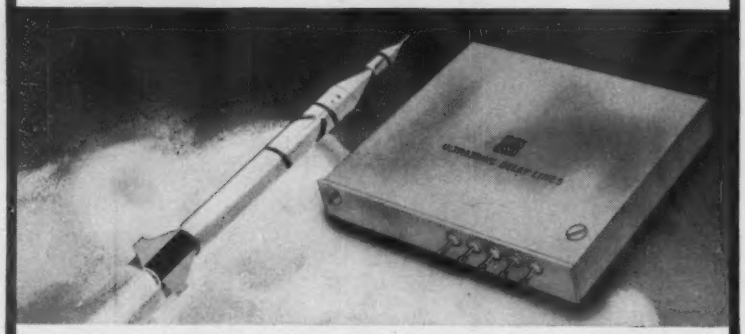
Communications, as essential to civilization as food and shelter, is an area of unlimited challenge which constantly occupies our efforts. To find more room within the radio spectrum for electronic communications — from direct current to the cosmic rays — is a major goal. Revolutionary ways to extend communications is another. We foresee early success with single satellite systems of the delayed-transponder type, and possibly passive reflector satellites. In only a few years ITT's "Earth Net" communication system may be a reality, providing global communications via three satellites in orbit. Within a generation, world-wide television may be a commonplace.

Positions of responsibility, challenge and reward are open to engineers with minimum B.S. degree and U.S. Citizenship. For information regarding specific positions, write G. T. Wall, Technical Placement Director.

ITT LABORATORIES
A Division of International Telephone and Telegraph Corporation
500 Washington Avenue, Nutley, New Jersey
Fort Wayne, Indiana • San Fernando and Palo Alto, California

CURTISS WRIGHT

ADVANCED DESIGN
COMPONENTS



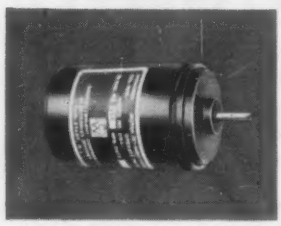
New ULTRASONIC DELAY LINES
Low cost — Small size

Development engineers can now employ new concepts in existing and proposed applications. These Curtiss-Wright delay lines are extremely small, hermetically sealed and vibration proof. They are ideally suited for use in computers, coders and decoders, telemetering and navigational systems.

SPECIFICATIONS

Delay range....5 to 6000 microseconds
Tolerance.....±0.1 microsecond
Signal to noise ratio..Greater than 10:1
Input & output impedance..50-2000 ohms
Carrier frequency.....100 kc-1 mc
Delay to pulse rise time....Up to 800:1

DIGITAL MOTORS
For high reliability applications



These stepping motors meet the requirements of assured reliability and long life for aircraft, missile and automation systems.

FEATURES

Dynamically balanced
Bi-directional • Positive lock
Simplicity of design
High pulsing rate

TIME DELAY RELAYS
For high vibration applications

"H" Series thermal time delay relays are designed to meet the high shock and vibration conditions of today's military applications.

FEATURES

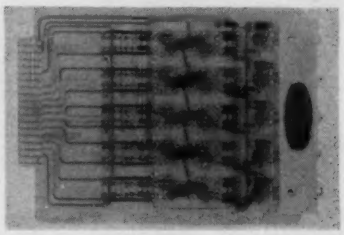
Time delays from 3 to 180 seconds
Temperature compensated
Hermetically sealed • Miniature
Meets rigid environmental specifications

WRITE FOR COMPLETE COMPONENTS CATALOG 159

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • WEST CALDWELL, N. J.

a single output line with negligible losses and distortion at rates of as high as 24,000 total samples per sec. Signals at full-scale amplitude levels of as high as ± 10 v may be multiplexed intermixed with signals at levels of as low as ± 10 mv.

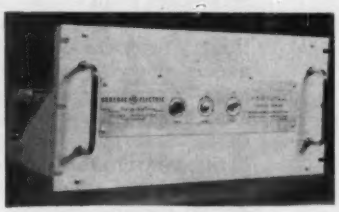
CIRCLE 307 ON READER SERVICE CARD



Flip-Flop Storage for digital data

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. Model 307 flip-flop storage register contains five independent transistorized flip-flops for the storage of digital data. Set and reset inputs and ONE and ZERO outputs are available for each flip-flop. A common buss is provided for simultaneous resetting of all five flip-flops. Model 307 is 5 by 6 in glass-epoxy p-c card, $\frac{1}{16}$ in. thick and is used with an 18 pin p-c receptacle. Only one voltage, −12 v is required. Standard levels are −6.8 v for ONE and −0.2 v for ZERO.

CIRCLE 308 ON READER SERVICE CARD

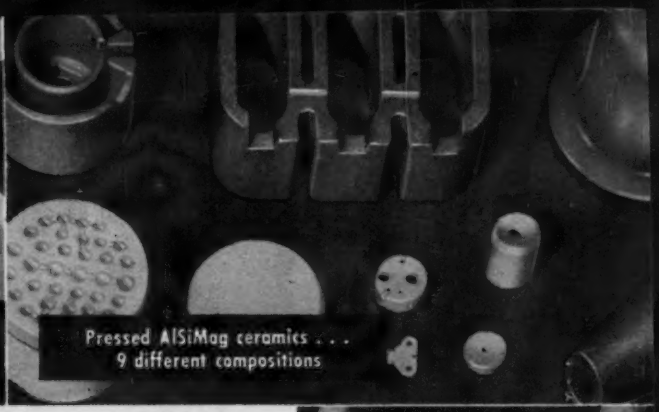


Voltage Regulator static components

GENERAL ELECTRIC Co., Pittsfield, Mass. The Sta-Vo-Trol voltage regulator uses special rate feedback and Zener diode sensing. Static components eliminate tubes, brushes and other moving parts. Rated 1 kva, single phase, 0 to 8.5 amperes, 120 v, the unit maintains ±0.25 percent bandwidth accuracy for a constant power factor load.

CIRCLE 309 ON READER SERVICE CARD

Extruded and machined parts . . .
8 different AlSiMag compositions



Pressed AlSiMag ceramics . . .
9 different compositions

Machined natural stone

AlSiMag®

offers . . .

the widest variety of technical ceramics from any single source

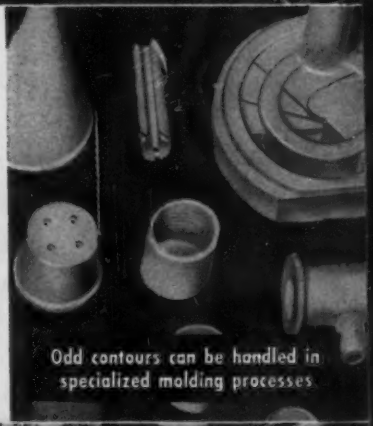
Specialized engineering talent in depth • The quantity you need . . . deliveries and quality as agreed • Special speedy service on prototypes • Specialized equipment for smaller quantity production • Unequaled facilities for volume production when you really need volume.

from one source . . .

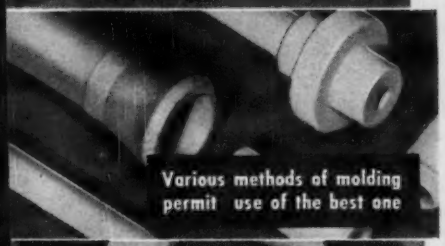
These are typical samples picked up in our Inspection Department over a week end. They illustrate the great variety of technical ceramics constantly flowing through our ultra-modern plants.

Parts are shown approximately ½ size.

Property Chart Sent on Request.



Odd contours can be handled in specialized molding processes



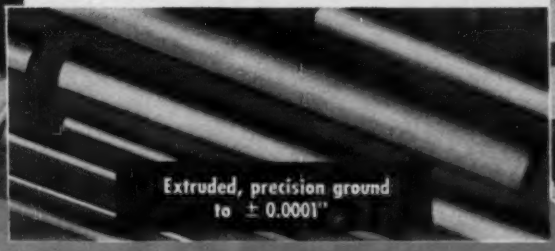
Various methods of molding permit use of the best one

AlSiMag metal-ceramic assemblies

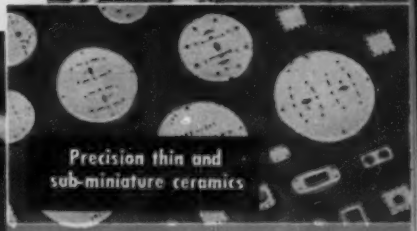
Casting handles larger shapes, odd contours

High temperature hermetic seals

Soft solder metalization



Extruded, precision ground to ± 0.0001"



Precision thin and sub-miniature ceramics

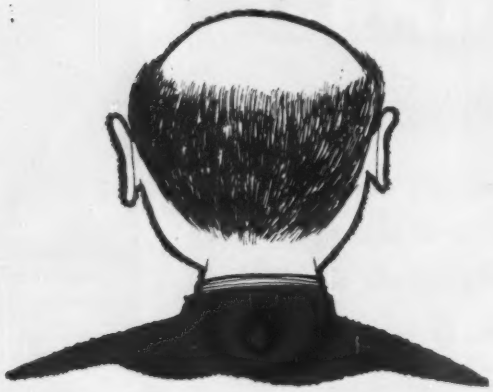
A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
50TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, O. • Dallas, Texas • Los Angeles, Cal. New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y. •

IT'S WHAT'S IN HERE THAT COUNTS



Do you know, for instance... which electronic stocks are hottest? Who's in the news and why? About "Three Approaches to Microminiaturization"? About the newest product ideas hitting the market? What's up in production? Opportunities overseas? What's going on in Washington?

It pays to know more than the next man! The questions above are just 6 reasons why you should subscribe to *electronics*.

IF YOU'RE ON THE TAG END OF A ROUTING SLIP, get your own subscription. Knowing what's going on is the first step to going *up*.

Fill in the coupon below right now... it will pay big dividends.

FIND WHAT YOU NEED IN... electronics

_____Renew my subscription for 3 more years.
_____Enter my new subscription.

U.S. Subscription Rates: _____3 years $12. _____1 year $6
Canadian rates $10 for 1 year. Foreign rates $20 for 1 year.

Name_____
Street_____
City_____Zone____State_____
Company_____
Street_____
City_____Zone____State_____
Your Title_____Department_____
Product Manufactured or Service Performed_____
Mail reply to: **electronics**, 330 West 42nd Street, New York 36, N. Y.

Literature of

MAGNETIC AMPLIFIER. Airpax Electronics Inc., Seminole Division, Fort Lauderdale, Fla. Bulletin M-62 describes the Preac, a high sensitivity d-c magnetic amplifier having an extremely stable null.

CIRCLE 350 ON READER SERVICE CARD

TEST EQUIPMENT. Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J. A 36-page catalog describes a complete line of equipment which measures the electrical characteristics of control synchros, torque synchros and computing resolvers.

CIRCLE 351 ON READER SERVICE CARD

SOLENOID-LOCK MECHANISM. Electro Switch Corp., King Ave., Weymouth, Boston 88, Mass. Bulletin No. 18 describes application of solenoid locking mechanism to standard ESCO type JR rotary switches.

CIRCLE 352 ON READER SERVICE CARD

MODULAR HOUSINGS. Stantron Division of Wyco Metal Products, 6914 Beck Ave., N. Hollywood, Calif. Catalog No. 100 completely describes and pictures a new line of modular electronic housings.

CIRCLE 353 ON READER SERVICE CARD

MAGNETIC TAPE ERASER. Southwestern Industrial Electronics Co., 10201 Westheimer, Houston 27, Texas. The MTE-2 magnetic tape eraser, designed to provide clean demagnetization of either direct or f-m recorded tapes, is described and illustrated in a recent bulletin.

CIRCLE 354 ON READER SERVICE CARD

DELAY LINES. Valor Instruments, Inc., 13214 Crenshaw, Gardena, Calif. Bulletin DL1159 describes a standard line of miniature lumped constant delay lines. Design factors that should be considered when establishing specifications for special delay lines are also explained.

CIRCLE 355 ON READER SERVICE CARD

ZIPPER TUBING. Alpha Wire Corp., 200 Varick St., New York 14, N. Y. Catalog Z-2 discusses the

the Week

characteristics, new constructions, applications, specifications, and production advantages of Alphlex zipper tubing.

CIRCLE 356 ON READER SERVICE CARD

C-BAND RADAR BEACON. General Electric Co., Schenectady 5, N. Y. Publication WCP59-0812 describes the C-band radar beacon, a 9.8 lb, airborne, pulse-type missile tracking and identification aid.

CIRCLE 357 ON READER SERVICE CARD

SUPERALLOYS. Metals Division, Kelsey-Hayes Co., New Hartford, N. Y. Two new technical bulletins cover performance data on vacuum induction melted Waspaloy and M-252 superalloys.

CIRCLE 358 ON READER SERVICE CARD

NYLON TIP JACKS. Herman H. Smith Inc., 2326 Nostrand Ave., Brooklyn 10, N. Y. Catalog No. 59 covers a line of molded Nylon tip jacks featuring metal shell which eliminates stripping threads during assembly.

CIRCLE 359 ON READER SERVICE CARD

FREQUENCY METERS. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa. Bulletin 32 on Frahm resonant reed frequency meters is now available.

CIRCLE 360 ON READER SERVICE CARD

COMPRESSION TERMINALS. Electrical Industries, 691 Central Ave., Murray Hill, N. J. Bulletin TCT-59-102 covers a line of glass-to-metal tubular single-lead compression terminals.

CIRCLE 361 ON READER SERVICE CARD

TESTING FACILITIES. Horkey-Moore Associates, 24660 Crenshaw Blvd., Torrance, Calif. A 4-page brochure describes the firm's environmental, qualification and reliability testing facilities.

CIRCLE 362 ON READER SERVICE CARD

GERMANIUM DIODES. General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y. Ten-page brochure GD-40 describes a complete line of germanium gold bonded diodes.

CIRCLE 363 ON READER SERVICE CARD

★ ULTRA LOW capacitance & attenuation

TYPE	μμF/ft	IMPED.Ω	O.D.
C 1	7.3	150	.36"
C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

WE ARE SPECIALLY ORGANIZED TO HANDLE DIRECT ORDERS OR ENQUIRIES FROM OVERSEAS
SPOT DELIVERIES FOR U.S.
BILLED IN DOLLARS—SETTLEMENT BY YOUR CHECK
CABLE OR AIRMAIL TODAY

NEW MX and SM SUBMINIATURE CONNECTORS Constant 50Ω 63Ω 70Ω impedances

TRANSRADIO LTD. 138A Cromwell Rd. London SW7 ENGLAND CABLES: TRANSRAD, LONDON

CIRCLE 201 ON READER SERVICE CARD

RIBBONS · STRIPS

—of—

★ PURE TUNGSTEN ★ THORIATED TUNGSTEN
★ MOLYBDENUM ★ SPECIAL ALLOYS

and OTHER METALS
IN
ULTRA THIN SIZES
to
TOLERANCES CLOSER THAN COMMERCIAL STANDARDS
by
OUR SPECIAL ROLLING TECHNIQUE

Note: for highly engineered applications—strips of TUNGSTEN and some other metals can be supplied

ROLLED DOWN TO .0003 THICKNESS

- Finish: Roll Finish—Black or Cleaned
- Ribbons may be supplied in Mg. weights if required

For HIGHLY ENGINEERED APPLICATIONS
DEVELOPED AND MANUFACTURED BY

H.CROSS CO. 15 BEEKMAN ST. N. Y. 38, N. Y. TELEPHONE WOrth 2-2044 COrtlandt 7-0470

CIRCLE 95 ON READER SERVICE CARD

Filtron Opens in Midwest

FILTRON CO., INC., of Flushing, N. Y., and Culver City, Calif., has opened a central regional field service office in Dayton, O.

The new facility will supply specialized radio-frequency interference engineering services to both industrial manufacturers and government agencies throughout the Midwest. Special services will be available to the U. S. Air Force complex at Wright-Patterson AFB, near Dayton.

Engineering facilities will include screen-room services, component and systems testing, and a model shop for producing prototype interference filters for special applications. In addition the branch will serve as a liaison unit of Filtron's Systems Engineering division, for consultation on r-f interference analysis and control.

John L. Moe, formerly a project engineer with Filtron's Systems Engineering division, will be engineering manager. Marketing manager for the new branch will be J. Kent Thompson, who has served as a field engineer for Filtron in the Ohio area for the past five years.

Bambara Joins Servo Corp.

JOSEPH E. BAMBARA has been appointed director of industrial products engineering for Servo Corp. of America, Hicksville, L. I., N. Y. He heads an engineering laboratory engaged in research, development and design of infrared instruments and systems, as well as control and data processing systems for industrial applications.

Before coming to Servo Corp., Bambara was for almost nine years with CBS Laboratories, where he was vice president of CBS' electronic systems laboratory.

Teleregister Ups Schneider

THE TELEREGISTER CORP., Stamford, Conn., has appointed Philip Schneider engineer-in-charge of the Systems Development Group, a new unit of the engineering department.

Function and responsibility of Schneider's group is to study and develop new concepts and requirements for input/output devices, communications systems, data processing systems and mathematical models and techniques required in the company's field of interest, which is the design, manufacture and operation of automated data processing systems.

Schneider has been a systems engineer with Teleregister since April 1959. He previously spent 7 years with Bell Telephone Laboratories as a member of the technical staff in switching systems engineering. He was in charge of a group responsible for engineering pcm transmission systems.

Corby Takes New Post

ROBERT R. CORBY has been appointed to the position of staff engineer in the program planning department of Motorola's Western Military

FOR RELIABILITY... FOR QUALITY... FOR SERVICE

Specify

KURMAN RELAYS

Immediate delivery from stock at factory prices thru
KURMAN SALES AGENCIES

These leading Distributors — Kurman SALES AGENCIES — stock our complete line

EAST
Almo Radio Co., Philadelphia
American Electronics, Rochester
Arrow Electronics, Inc., Mineola
Cramer Electronics Inc., Boston
Hi-G Electronics, Inc., Rochester
Higgins & Sheer, Poughkeepsie
Lafayette Radio, Boston & New York
Mace Electronics, Erie, Pa.
Milo Electronics Corp., New York
Quad Electronics, Inc., Brooklyn
Radio Equipment Corp., Buffalo
Schenectady Electronic Dist. Corp., Schenectady
Stack Electronics, Inc., Binghamton
Terminal Radio Corp., New York
Valley Electronic Lab, Inc., Utica
Wholesale Radio Parts Co., Baltimore

SOUTHEAST
Electra Distributors, Nashville, Tenn.
Electronic Equipment Co., Miami, Fla.
Forbes Electronic Distributors, Mobile
Frock Radio & Supply Co., Inc. Asheville, N.C.
Glenn Allen Co., Inc., Memphis, Tenn.
Goddard Distributors, W. Palm Beach
Southeast Audio Co., Jacksonville, Fla.

MIDWEST
Industrial Electronic Supply of Grand Rapids, Grand Rapids

MIDWEST (Cont.)
Interstate Supply Co., St. Louis
Pioneer Electronic Supply Co., Cleveland
Radio Parts Co., Milwaukee
Relay Sales, West Chicago
Sun Radio Co., Akron

SOUTHWEST
Bosscher Electronic Equipment, Houston
Central Electronics, Dallas
Lavender Radio Supply Co., Inc. Tyler, Tex.
Lenert Co., Houston
Midland Specialty Co., El Paso, Texas
Trice Wholesale Electronics, Oklahoma City

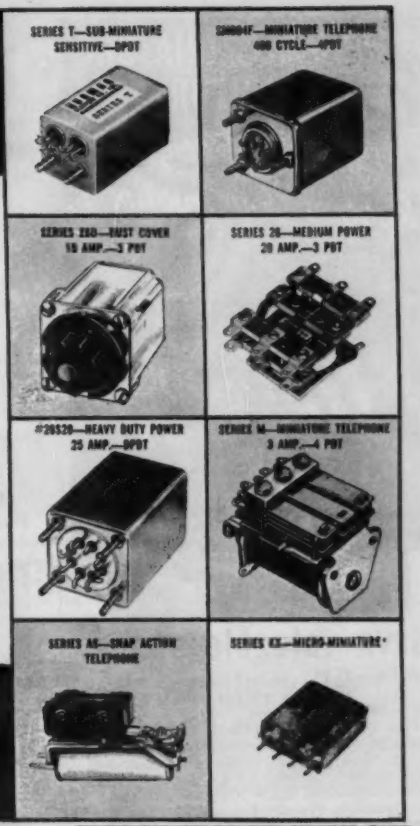
WEST
Aviomic Supply, Culver City, California
Ballard Supply Co., Ogden
C & G Radio Supply, Seattle, Centralia, Tacoma, Bremerton, Olympia, Aberdeen
Bean Electronics, Long Beach, Calif.
Frank Quement, Inc., San Jose
Sacramento Electronic Supply, Sacramento
Silvergate Radio Supply, San Diego
Tel-Electric Distributors, Inc., Spokane
Universal Radio Supply Co., Los Angeles

Shown here are only a few of the many KURMAN RELAYS stocked by the leading distributors throughout the country.

CATALOGED IN MASTER

See our catalog pages in the Radio-Electronic **MASTER**

Contact your Sales Agency or factory for your specific requirement and FREE "Quick-Find" Relay Spec. Chart.


SERIES T—SUB-MINIATURE SENSITIVE—DPDT
SERIES 28—MEDIUM POWER 20 AMP.—3 PDT
SERIES M—MINIATURE TELEPHONE 3 AMP.—4 PDT
SERIES AS—SNAP ACTION TELEPHONE
SERIES KS—MICRO-MINIATURE

KURMAN ELECTRIC CO.
Subsidiary of Crescent Petroleum Corp. Quality Relays Since 1928
191 Newel St., Brooklyn 22, N. Y.
Export: 135 Liberty St., N.Y.C. Cable: TRILRUSH

CIRCLE 202 ON READER SERVICE CARD

KYORITSU ELECTRICAL INST. WORKS, LTD.
NO. 120, Nakane-cho, Meguro-ku, Tokyo, Japan.
Cable Address "KYORITSUKEIKI TOKYO"

CIRCLE 203 ON READER SERVICE CARD

HERE'S GOOD NEWS IF YOU BUY PLATING...

A PRECIOUS METAL PLATER WHO KNOWS ELECTRONICS PLATING!

No plating problems on your next project if you call Cohan-Epner now.

Whether you're setting your "spec" to reduce slip-ring "noise" or increase contact wear — or for corrosion-resistance or conductivity — Cohan-Epner hits your most rigid specs and quality requirements "on the nose"!

Leaders in precious metal plating for more than 47 years — specialists in electronics — our technically trained experts understand your intricate electronics plating problems. We'll be happy to discuss your project and its requirements in your own engineering terms.

The quality of our work — highest Q.C. standards — and the reliability of our service are known throughout the industry. Over the years, our list of steady customers has grown. Add your name to it.

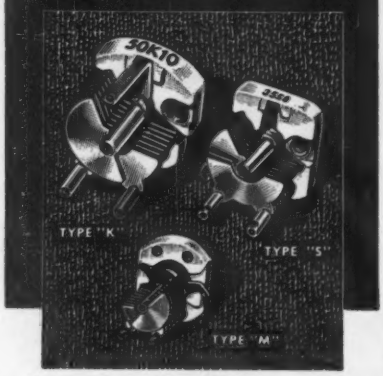
Rush jobs, non-rush jobs . . . give us a call now — and relax!

COHAN-EPNER COMPANY
Precious Metal Plating
DEPT. E-20, 142 WEST 14TH STREET, NEW YORK 11
CHelsea 3-3411

CIRCLE 97 ON READER SERVICE CARD

JOHNSON MINIATURE CAPACITORS

Compact Design! Rugged Construction!



Save valuable space in RF equipment...

Johnson miniature and sub-miniature air variable capacitors are available in a wide range of sizes, types, and capacities—perfect for use in compact RF applications. The 3 types described below have soldered plate construction, oversize bearing, and heavily anchored stator supports to provide extreme rigidity. Inductance path to both stator supports is extremely low with bridge-type stator terminal. Large compression rotor contact provides steady torque—rotor stays "put" where set. Rotor contact and all other metal parts are nickel-plated—steatite insulator is DC-200 treated.

SUB-MINIATURES—In addition to the miniature air variables described below, the new Johnson Type "C" and "U" sub-miniature capacitors are also available in production quantities. Write for our new components catalog 978 listing complete specifications.

TYPE "M"—Peak voltage 1250 volts on .017" plate spacing; 850 volts on .013" spaced units. Shaft slotted for fast screwdriver adjustment—mounting bushing threaded with flats to prevent turning—mounting nut furnished. Available in production quantities with the following features: locking bearings; 180° stop; various shaft extensions; high torque; silver or other platings. Single section, butterfly, and differential types available.

TYPE "S"—Midway in physical size between the Type "M" and "K" capacitors, the Type "S" has a plate spacing of .033" with a peak voltage rating of 850 volts. Other spacings, single hole mounting types, straight shaft, screwdriver shaft, or locking type screwdriver shaft available on special order in production quantities.

TYPE "K"—Widely used for many military and commercial applications, the Type "K" has a peak voltage rating of 1000 volts with a plate spacing of .015". Unit is available in production quantities to meet MIL-C-92A specifications—other capacities and variations for specialized military and commercial applications are also available in production quantities.

New Catalog

For detailed specifications, including engineering drawings, on Johnson miniature and sub-miniature capacitors, as well as other Johnson electronic components, write for your free copy of our new components catalog No. 978.

E. F. JOHNSON CO.
1820 Second Avenue S.W. • Waseca, Minn.

Electronics Center, Phoenix, Ariz. He joined Motorola in 1953 as assistant manager in microwave products in Chicago. In 1955 he became manager of military microwave sales and in 1958 was transferred to the Military Electronics Division in Phoenix as marketing coordinator for the company's six military plants.

In his new position Corby will be responsible for the development of new areas of product and program activities. This will include the analysis, organization and coordination of technical and promotional effort required to match Motorola's skills most appropriately to the military's needs.

Spectrol Hires D. C. Beem

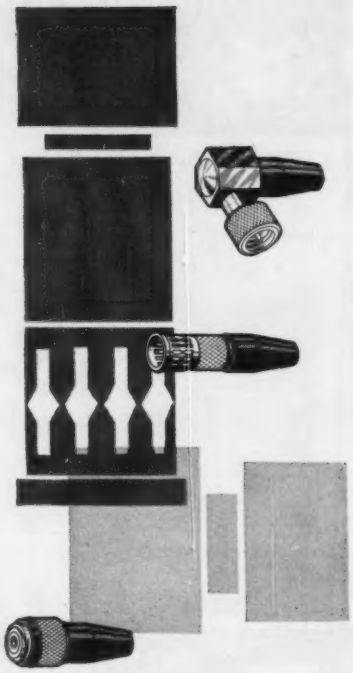
DONALD C. BEEM has been named senior design engineer in charge of design and development of solid state power supplies of the Special Products Group of Spectrol Electronics Corp., San Gabriel, Calif., manufacturer of precision electronic components.

Prior to joining Spectrol, Beem was in charge of quality control at Owens Labs of Pasadena.

News of Reps

Two manufacturers' reps were recently appointed to handle commercial-industrial products of Lear Inc., Grand Rapids, Mich.

Berndt Associates of Glencoe, Ill., will cover the states of Wis-



micro-miniature connectors

Designed to meet present-day critical miniaturization requirements, these new connectors are available in both threaded (MTM), and slide-on (MSM) versions.

They are available for use with all existing micro-miniature and sub-miniature cables.

These connectors mate with and are interchangeable with existing micro-miniature connectors.

No special tools are required for assembly.

Brochure with technical information available upon request.

Automatic
METAL PRODUCTS CORPORATION
323 BERRY STREET, BROOKLYN 11, N. Y.
EVergreen 8-6057

consin and Illinois and the Gary, Ind., area.

Electro-Mation Associates of Warren, Mich., will handle sales in Michigan and the Toledo, Ohio, area.

Maxwell S. Symon, formerly sales manager of Electric Regulator Corp., has formed a new sales rep organization known as **Symon Associates** in New York City. His organization will represent components and instrument manufacturers in the metropolitan New York area.

Ovenaire, Charlottesville, Va., manufacturer of crystal and component ovens, names **Kenneth E. Hughes Co., Inc.,** of Union City, N. J., as sales rep for New York State and northern New Jersey.

Paul G. (Tiny) Yewell of Yewell Associates, Burlington, Mass., electronic representatives, announces the appointment of **Philip P. Perry** as business manager. He will handle business affairs for the electronic sales and service organizations and coordinate the field activities of the Eastern Division offices at Bridgeport, Conn., and Poughkeepsie, N. Y.

Ace Electronics Associates, Inc., manufacturer of precision wirewound and conductive plastic potentiometers and trimmers, announces the appointment of the following reps:

C. H. Roller Sales, Inc., for the Michigan territory; **Callaghan-Bach, Inc.,** for southwest Ohio; and **Thunderbird Engineering Sales & Services, Inc.,** for St. Louis, Mo., Wichita, Kan., and Kansas City, Mo.

Paul Epstein was recently added to the sales staff of **Jules J. Bressler Co.,** Union City, N. J., manufacturers' rep firm.

The Government & Industrial Division of Philco Corp., Philadelphia, Pa., has appointed **Western Scientific Contracting Corp.,** Redwood City, Calif., as sales and service rep for its closed circuit tv equipment and systems throughout northern and central California and Nevada.

NORTHERN RADIO COMPANY
INCORPORATED
NEW YORK, N.Y.
PRINTER RELAY
TYPE 237
MODEL
SER.
NEW
TRANSISTORIZED
PRINTER RELAY
Type 237
Model 1
• replaces electro-mechanical signal relays
• eliminates associated local DC power supplies
• eliminates electro-mechanical maintenance problems
• isolates the reactance of printer selector magnet
• presents resistive termination to the signal loop
Pace-Setters in Quality Communication Equipment
NORTHERN RADIO COMPANY, inc.
147 WEST 22nd ST NEW YORK 11 NEW YORK
In Canada: Northern Radio Mfg. Co. Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario

Write on your letterhead for free literature to Dept. E-1.

CIRCLE 209 ON READER SERVICE CARD

There's going to be a meeting

Who's going to get together and *what* are they going to talk about?

Electronics men are meeting all over the country to talk about everything from ultrasonics to quantatum electronics.

electronics tells you where and when *"Meetings Ahead"* . . . gives you the highlights later on.

Another reason why it will pay you to subscribe to *electronics* (or renew your subscription) right now. Fill in the box on Reader Service Card. Easy to use. Postage free.

FIND WHAT YOU NEED IN...

electronics

A Message to Executives Seeking a New Plant Site

Check these 3 Important Plant Location Advantages in

PENNSYLVANIA

100% financing for your new plant

Complete financing on lease-purchase plan—low interest rate—deferred amortization. Plant "shells" now being readied for completion. Inspection welcomed.

Improved "tax climate"

No capital stock and franchise taxes—no machinery and equipment taxes—no stock transfer tax—no state personal income tax—reduced manufacturer's sales tax.

Plant location services

Staff specialists available to serve industry, engineering firms, management consultants, industrial realtors and others with fully detailed plant location data.

For free copy of pamphlets on these Pennsylvania Plant Location Advantages, write or call:

PENNSYLVANIA DEPARTMENT OF COMMERCE
South Office Building
659 State Street, Harrisburg, Pa.
Phone: CEdar 4-2912

COMMENT

The Old Returneth

This nostalgic discussion came in with our New Years' mail, appropriately enough.

Normally I try to obey the old adage that old people shouldn't live in the past. However, a story on old-time equipment brought back memories of old-time rigs, and I began to wonder if some use couldn't be found for this gear in the missile age. In checking I was surprised at the amount of old equipment that already had been modernized . . .

The exasperating cat-whisker detector has grown into the dependable crystal diode and ultimately into the transistor. The most unreliable coherer is now on the market as a semiconductor relay. Magnetic recording, which dates from the 1880s, now puts out hi-fi and the Geisler tube has become a neon sign. I have even seen a William Duck super double slide tuner, all automatic.

Now, as near as I can figure, this leaves the magnetic, electrolytic and loose-contact detectors, and spark and arc generators—but how to modernize them will have to be someone else's problem: I am 65 years old. I believe that no real engineering has ever been done on these items, which date from the days when radiation was propagated through a mystical ether—or, as some theorists had it, there was no radiation at all, only earth conduction.

About the earliest attempt at wireless communication was placing two ground rods alongside of a small river, placed a considerable distance apart. These were connected with a battery and mike in series. Across the river, two similar ground rods were placed a shorter distance apart and connected to phones. Stray earth currents with voice would be picked up by the phones. I am very dubious that this system will be modernized, as it was easier to shout across.

Operation of magnetic detectors depends on the fact that when iron is in the process of being magnetized, it is very sensitive to small changes in the magnetizing force.

send for this
FREE
EICO Electronics Catalog

you save 50% on Top-Quality
Test Instruments
HI-FI • Ham Gear
KITS AND WIRED
for professional and home use

TEST INSTRUMENTS
battery eliminators
battery testers
bridges
decade boxes
electronic switch
flyback tester
oscilloscopes
probes
signal and sweep generators
tube testers
transistor tester
vacuum tube voltmeters
volt-ohm-milliammeters

HI-FI
stereo and monaural tuners
preamplifiers
power amplifiers
integrated amplifiers
speaker systems

HAM GEAR
cw transmitter
modulator-driver
grid dip meter

OVER 1½ MILLION EICO instruments in use throughout the world.

LIFETIME service and calibration guarantee.
IN STOCK at your neighborhood EICO dealer.
Send now for FREE catalog E-1B

EICO 33-00 N. Blvd., L. I. C. 1, N. Y.
praised by the experts as BEST BUYS IN ELECTRONICS

CIRCLE 205 ON READER SERVICE CARD

WHO DROPPED THE BINOCULARS?

With everybody watching each other along the DEW line and the Iron Curtain these days, **electronics** has replaced binoculars.

What's happening in the giant markets for missile controls, radar and communications equipment?

electronics tells how things are going, keeps you informed of developments as they occur. This is a good time to subscribe or renew your subscription. Just fill in box on Reader Service Card. Easy to use. Postage free.

FIND WHAT YOU NEED IN... electronics

SOON

You will receive a QUESTIONNAIRE for Free Listings in the 1960-1961 electronics BUYERS' GUIDE and Reference Issue

As soon as you receive the new questionnaire, please fill it out accurately and return promptly. List ALL your products . . . and, remember, to receive free listings, proof of production of all your products must be included.

If someone other than you in your organization should fill-in the questionnaire, kindly pass it on to that person and advise us immediately so we can correct our mailing lists.

A Record for your Company's Advertising

The *electronics* BUYERS' GUIDE is the established, basic advertising media for anyone who sells to the electronics industry. List your products on the CHECK SHEET attached to the questionnaire and send it to your advertising manager or advertising agency. The CHECK SHEET will be a valuable aid in preparing your catalog-type BUYERS' GUIDE advertising – the one place where you *sell your entire product line.*

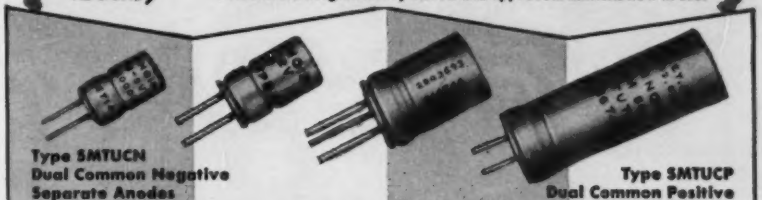
A McGraw-Hill Publication

330 W. 42nd Street, New York 36, N.Y.

ILLINOIS *UP-RIGHT* Miniature Electrolytic Capacitors . . .
Type SMTU finest for
TRANSISTORIZED CIRCUITRY

Time Tested Quality

Aluminum cased, with exclusive patented hermetic sealing. Stable under temperature extremes — stable to shock and vibration. Guaranteed long life. Fully tested and approved. Millions now in use.



Type SMTUCN
Dual Common Negative Separate Anodes

Compact construction permits exceptional space savings and economy which is highly desirable in modern transistor circuitry. One capacitor saves space where normally two individual capacitors were previously needed. These dual units are ideal for bypass, filtering or coupling where a common ground exists.

Type SMTUCP
Dual Common Positive Separate Cathodes

These dual section common anode constructed capacitors have cathodes which are electrically separated and isolated. Unique construction with "floating" cathodes makes these ideal for coupling, filter and bypass circuits for "above ground" applications.

Temperature Range: −40 to +65°C; also available −30 to +85°C
Voltage Range: 3 to 250 volts

ILLINOIS CONDENSER COMPANY
1616 NORTH THROOP STREET
CHICAGO 22, ILL. EV 4-1300

Write for complete technical literature

Export Department: 15 Moore Street, New York 4, New York

CIRCLE 210 ON READER SERVICE CARD

UST TOP QUALITY TRANSISTORS
Proven Reliability for all Applications

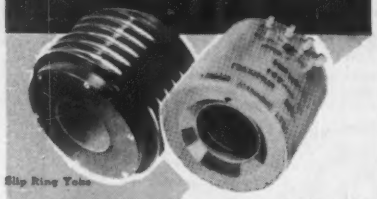
US Transistor's complete range of commercial and industrial transistors are applicable for every purpose. Separately designed series offer the characteristics that will suit your individual requirements. All the transistors listed in the adjoining table have welded hermetic seals and meet or exceed mechanical and environmental requirements.

Small Signal Audio and Low Speed Switching Transistors	Extended Audio and Medium Speed Switching Transistors	Radio Transistors I.F. and Oscillator	Medium and High Speed Switching Transistors (Computer)	
2N362	2N519	2N481	2N404	2N315
2N363	2N520	2N482		2N316
	2N521	2N483	2N425	2N317
2N464	2N522	2N484	2N426	
2N465	2N523	2N485	2N827	2N1343
2N466		2N486	2N828	2N1344
2N467				2N1345
		2N413	2N1280	2N1346
2N631		2N414	2N1281	2N1347
2N632		2N416	2N1282	
2N633		2N417	2N1284	2N1353
				2N1354
2N680			2N1316	2N1355
2N681			2N1317	2N1356
2N682			2N1318	2N1357
2N683				
2N684				
2N685				

Write today for engineering data sheets or personal application assistance.

U. S. TRANSISTOR CORP.
149 Eileen Way, Syosset, L. I., N. Y. • WAlnut 1-5800

PRECISION DEFLECTION
WITH
COSSOR YOKES



Slip Ring Yoke

Two-Axis Fixed Yoke

Component Development Engineering at its BEST!

- ADVANCED ELECTRICAL DESIGN
- PRECISION MECHANICAL DESIGN
- ACCURATE PRODUCTION METHODS

Custom Built to the most
Exacting Specifications
by Cossor Engineers

In Mumetal Cores for Optimum Geometry
In Ferrite Cores for Speed and Sensitivity
In Non-magnetic Cores for Perfection of Response

Any of Cossor's Three Core Types can be made in single or double axis with single or push-pull windings, and encapsulated for fixed or slip ring (rotating) use

Normal characteristics of yokes for 1-1/2 in neck tubes are

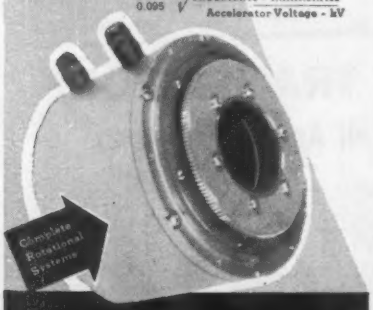
Positional accuracy — the spot position will conform to the yoke current co-ordinates within 0.25% of tube diameter. For deflection angles less than ±25° better accuracy can easily be achieved

Memory — 0.5% max without overswing
0.1% or less with controlled overswing

Complete encapsulation in epoxy (stycast) or silicone resins is standard for all Cossor deflection yokes, and is done with special moulding tools ensuring accurate alignment of the yoke axis. When slip rings are added, solid silver rings are mounted in encapsulating resin. The finished slip ring yoke is precision turned to centre bore, and can include bearing mounting surfaces with dimensional tolerances approaching those associable with high quality metal parts.

Settling Time (Micro sec.) = $\frac{}{120 \sqrt{\text{Inductance in Henries}}}$

Sensitivity degrees/milliamperes = $\frac{}{0.095 \sqrt{\frac{\text{Inductance - millihenries}}{\text{Accelerator Voltage - kV}}}}$



COMPONENTS DIVISION

E.M.I
COSSOR
Electronics Limited

WOODSIDE, DARTMOUTH, N.S.
2005 Mackay St., Montreal, Que.
3077 Bathurst St., Toronto, Ont.
Corporation House, 160 Laurier West, Ottawa, Ont.

The old magnetic detectors consisted of a flexible band of insulated wire moved by clockwork around two pulleys. The tube through which the band passed contained a primary winding in series with the antenna. A secondary winding connected through the phones. Close to the windings were placed the poles of two magnets which magnetized the band of wires. Oscillations in the primary produced momentary changes in the magnetization of the bands under the magnets, and these changes induced oscillating audio currents in the secondary, which operated the phones.

With some trepidation, I will say this principle has never been used since the early days.

The loose-contact coherer consisted of a needle placed across a pair of sharpened carbon blocks, where the variable resistance modulated the r-f carrier. I am certain no one would want to bring this back. However, when placed on a concrete pier, it made a very sensitive pickup for earth noises.

The electrolytic coherer was usually made of a fine platinum wire touching a 20-percent sulphuric acid electrolyte in a platinum cup. A critically small current was introduced through an r-f choke, which soon polarized the cell and current ceased. When the r-f to be detected was introduced across the cell, the molecular film broke down and current flowed. Possibly some use could be found for this device, which I do not believe has been used for fifty years.

The old spark transmitter—a high-voltage transformer charging a capacitor which was in parallel with a spark gap and the primary of an r-f transformer—is definitely out as a communications transmitter, although at the present time it is being used in industrial heating.

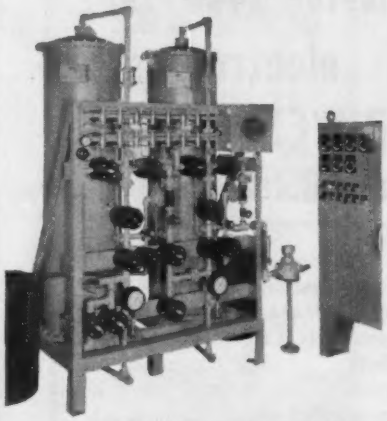
The Alexanderson r-f alternator, which consisted of a toothed rotor revolving at high speeds past d-c powered stator windings, is probably hopeless for this age of high frequencies.

Modern technical progress might find some use for this historical equipment—but I am willing to pass over if I ever hear of a spark transmitter on a missile.

DEXTER S. BARTLETT
SEATTLE, WASH.

SET IT DOWN!
HOOK IT UP!

ILLCO-WAY
ionXchange
EQUIPMENT



COMPLETE
AUTOMATIC
DE-IONIZER

Here is a complete, loaded, fully-instrumented, *automatic* ionXchange unit in a neat, compact, and *ready-to-operate* "package." It is equipped with our own Illco/Matic, all-plastic, air-actuated valves, which have been specially developed for ionXchange service. The Control Panel, also our own design and manufacture, provides all necessary quick-adjustment features, and requires only electrical hook-up to the terminal box on the frame. The only other connections required are to plant service.

FULLY ASSEMBLED AND READY TO INSTALL

All structural assembly of elements, all piping, all wiring, and all installation of air lines is done in our factory by men of long experience. Then the unit is tested for proper operation of all circuits, loaded with the proper supporting beds and resins, painted, bolted to a skid, and crated for delivery to the exact spot it will be used. *This is the quickest, easiest, and surest way for you to get a reliable, ready-to-go ionXchanger* — arranged and instrumented to suit your special needs, whatever they are.

Write for Particulars

ILLCO-WAY
ILLINOIS WATER TREATMENT CO.
840 Cedar St.
Rockford, Ill.

NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Can.

CIRCLE 208 ON READER SERVICE CARD

CIRCLE 102 ON READER SERVICE CARD

EMPLOYMENT OPPORTUNITIES

The advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

— RATES —

DISPLAYED: The advertising rate is $34.33 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED: $2.40 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box numbers—count as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send New Ads on ELECTRONICS Class. Adv., P. O. Box 12, N. Y. 36, N. Y.

SELLING
TO THE
EUROPEAN MARKET

Excellent sales opportunities exist in the European Common Market for industrial equipment and technical products. A New York international business firm with office in Geneva, and established marketing outlets throughout Europe, is interested in adding several selected manufacturing accounts. We function as your European sales office, and represent you on the highest commercial and technical levels.

Only reputable firms with good references considered.

Box H-22, Suite 1606,
Times Tower Bldg., New York 36, N. Y.

ELECTRONIC ENGINEERS

Circuits; Micro-wave; instrumentation; semiconductors, etc.—also sales. Nationwide listings—many fee paid. Phila. interviews—

HEILVEIL & WOOD (Emp. Agcy)
830-31 Land Title
Phila., 10 **LO 4-2060**

Put Yourself in the Other Fellow's Place

TO EMPLOYERS - TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

Mr. Employer, won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

Mr. Employee you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section.

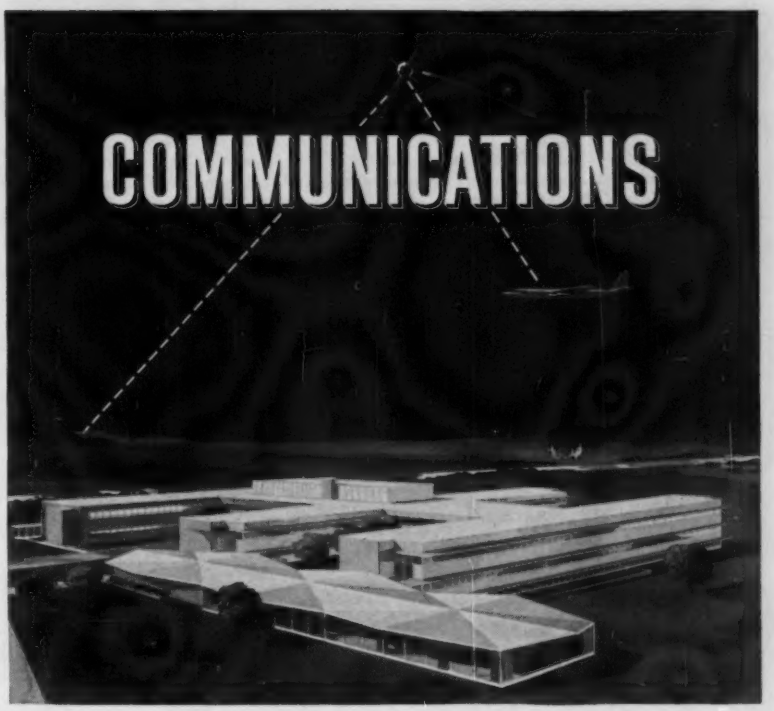
We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be the more useful to all as a result of this consideration.

Classified Advertising Division

McGRAW-HILL PUBLISHING CO., INC.

330 West 42nd St., New York 36, N. Y.



At Bendix Systems Division, advanced communications research is being carried out for the Nation's most challenging space and defense systems. New opportunities are offered in such areas as:

SATELLITE COMMUNICATIONS—Equipment design and system studies for the SAC Polar Satellite Communications System.

JAM-RESISTANT COMMUNICATIONS—Analysis, design and laboratory demonstration of jam-resistant modulation and AFC techniques.

MISSILE SYSTEM COMMUNICATIONS—Analysis of EAGLE communication requirements & instrumentation techniques.

SATELLITE NAVIGATION—Preliminary system design of airborne, ground and satellite equipments for global navigation.

PROPAGATION—Applied research & analysis of propagation through the plasma sheath surrounding hypersonic vehicles.

MAGNETOHYDRODYNAMICS—Advanced studies in MHD mode coupling for information transfer.

RADIATION-RESISTANT SUBSYSTEMS—M&TC equipment designs for airborne and space radiation environment.

Ann Arbor, home of The University of Michigan, is an ideal residential and professional environment for Bendix scientists and engineers. Your academic program can be continued with day-time graduate studies at U. of M. You can enjoy year 'round recreation, Big-Ten sports, concerts, and plays available in the Ann Arbor area. You will live in residential areas so close to work that big city commuting is unnecessary.

Contact us today for information about career opportunities in:

ANTENNA DESIGN
CIRCUIT DESIGN
NETWORK SYNTHESIS
INFORMATION THEORY
PROPAGATION
RADIATION EFFECTS
PACKAGING
SYSTEMS DESIGN & ANALYSIS

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

SCIENTISTS ..... ENGINEERS
stretch your imagination

...at Beckman Instruments, last refuge of the Non-Organization Man. Here's a company that is concerned with the man, his mind and his original contributions.

Commercial, industrial and military projects tickle the fancy of unconstrained intellects at these Beckman Divisions:

Beckman / *Scientific and Process Instruments Division*
Systems Division
Helipot Division

Don't get crushed in the Organization Mill...look into these imagination stretching positions...

ENGINEERS/SCIENTISTS...

at all levels in the fields of precision electronic components and analytical instrumentation for engineers and scientists with degrees in engineering or physical science. Some of our specific needs include project engineers, senior scientists or engineers, product engineers and senior electronic engineers. We also have openings for exceptional recent graduates.

And you can stretch your legs in Orange County, too, where you and your family will enjoy Southern California living at its barbecuing best.

Overcome your own organizational inertia...phone, wire or write Mr. T. P. Williams for all the parameters.

Beckman Instruments, Inc. Fullerton, California *B.I.I.*
Telephone TRojan 1-4848; from Los Angeles OWen 7-1771. *© 1960.*

SEARCHLIGHT SECTION
(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

ADDRESS BOX NO. REPLIES TO: Box No.
Classified Adv. Div. of this publication.
Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

BUSINESS OPPORTUNITY

Company French American management manufacturing resistors and silvered mica capacitors wishes to cooperate with American producer of electronic components interested in the opportunities offered by the European common market. BO-3473, Electronics.

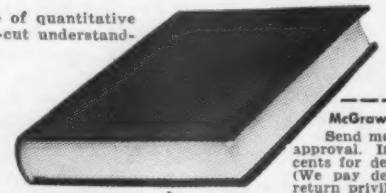
Practical working aids in the electronics field

PRINCIPLES OF CIRCUIT SYNTHESIS

Introduces the principles of modern circuit synthesis together with the key aspects of classical filter theory. The topic of synthesis is introduced with a discussion of typical communication and control systems. A discussion of the approximation problems and basic concepts and techniques of network realization follows. **By E. S. Kuh and D. O. Pederson, Assoc. Professors, U. of California, Berkeley. 244 pp., 300 illus., $8.50**

TRANSISTOR ELECTRONICS

Brings you a profitable working knowledge of quantitative transistor circuit design, based on a clear-cut understanding of the internal workings of the transistor device. Assures useful design accuracy without requiring a prior knowledge of quantum mechanics. **By David DeWitt, IBM Data Proc. Div., and Arthur L. Rossoff, Radio Receptor Co. 381 pp., illus., $8.00**



MICROWAVE MEASUREMENTS

Modern microwave measuring techniques that help you accurately determine the behavior of electromagnetic waves. Covers the full scope of the field, starting with the generation and detection of microwave signals and progressing through measurement of impedance, wavelength, frequency, and other major topics. **By Edward L. Ginzton, Professor of Applied Physics and Electrical Eng., Stanford U. 514 pp., 375 illus., $12.50**

SELECTION and APPLICATION OF METALLIC RECTIFIERS

Provides quick, reliable answers to rectifier and rectifier circuit probems—all necessary data on filters and transformers—and the essential mathematical tools to deal with circuit design. By developing together a clear idea of circuits and cell characteristics the book shows design procedures for such uses as pulse circuits, industrial and electroplating power supplies, battery charging, and others. **By Stuart P. Jackson, Gen. Elect. Co., 326 pp., 216 illus., $8.00**

FEEDBACK CONTROL SYSTEMS

Clearly develops techniques and theory for the full range of feedback problems—including those involved in process controls, servomechanisms, traffic, economics, and conservation. Precisely correlates such areas as phase plane, statistical methods, log gain plots, transient and steady state responses.

By Otto J. M. Smith, Prof. of Elec. Engrg., U. of Cal. 671 pp., 343 illus., $13.50

SEE ANY BOOK 10 DAYS FREE

McGraw-Hill Book Co., Dept FL, 327 W. 41st St., New York

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

- ☐ Kuh & Pederson—Princ. of Circ. Syn., $8.50
- ☐ DeWitt & Rossoff—Trans. Elec., $8.00
- ☐ Ginzton—Microwave Meas., $12.50
- ☐ Jackson—Sel. & App. of Metal. Rect., $8.00
- ☐ Smith—Feedback Control Sys., $13.50

Name..... Address.....

City..... Zone..... State .....

Position..... Company.....

For price and terms outside U.S., write McGraw-Hill Int'l. N. Y. C. FL 1-29-60

ELECTRONIC

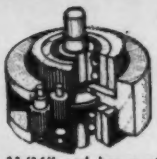
WAR TERMINATION INVENTORIES

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F.O.B. PASADENA, CALIFORNIA

C&H SALES CO.

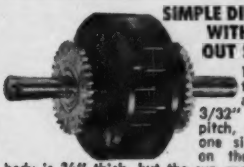
2176-E East Colorado St.
Pasadena 8, California
RYan 1-7393

SIMPLE DIFFERENTIAL WITH BALL-BEARING SUN GEARS



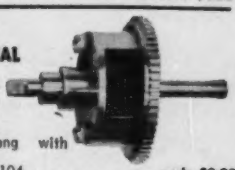
The 1:1 reverse ratio spur gears are 48-tooth, 32 pitch brass with 3/16" available face. On one side, the shaft is 23.64" dia. for 11/16" and has a pin hole, then increases in dia. to .377" for the remaining 3/16" of length. On the other side, the shaft is .377 dia. ¼" lg. 2-13/16" dia. is required to clear the body.
Stock no. A6-115.....each **$15.00**

SIMPLE DIFFERENTIAL WITH SPACED-OUT SUN GEARS



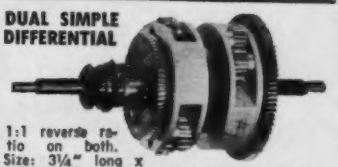
1:1 reverse ratio spur gears are aluminum, 3/32" face, 32 pitch, 32 tooth on one side, 48 tooth on the other. The body is ¾" thick, but the sun gears are spaced out so that they are 1½" apart. ¼" dia. shaft on each side is 23/32" long. OA length 3⅛". Requires 1-23/32" dia. to clear the body.
Stock no. A6-124.....each **$4.50**

SIMPLE DIFFERENTIAL



1:1 reverse ratio, 60 teeth on large gear; ¼" shaft. Size: 3" long with 1-15/16" dia.
Stock no. A6-104.....each **$3.95**

DUAL SIMPLE DIFFERENTIAL



1:1 reverse ratio on both.
Size: 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 5/32".
Stock no. A6-107.....each **$7.50**

SPERRY VERTICAL GYRO

Part #673073, Motor 115 volts, 3 phase, 400 cycle, 8 watts, 20,000 RPM. 3-minute runup, synchro pickoffs, roll 360°, pitch 85°. Synchro excitation 26 volts, 400 cycle, 150 m.a. Vertical accuracy ±½°. Weight 3½ lbs. Approx. dim. 5¾" L., 4½" W., 4½" H.
Price $35.00

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

Part no. JG7005A, 115 volts A.C., 400 cycle, single phase potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64.
Price $22.50

VARIABLE SPEED BALL DISC INTEGRATORS (All Shafts Ball Bearing Supported)

No. 145 Forward & Reverse 2¼-0-2¼. Input shaft spline gear 12 teeth 9/32" dia. ⅜" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x ⅜" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾".....**$17.50**

No. 146 Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long; Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4". **$18.50 ea.**

SMALL DC MOTORS

(approx. size overall 3¾" x 1¼" dia.:)

5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm.	$7.50
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
#5069625 120 rpm, mfr. Delco, 27 VDC governor controlled	$15.00
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
#5069800 575 rpm, mfr. Delco, 27 VDC, PM reversible governor controlled, equipped with 27 VDC clutch	$17.50
5072735 Delco 27 VDC 200 rpm governor controlled.	15.00
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm	15.00
5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., .7 amp. contains brake	15.00
5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp	15.00

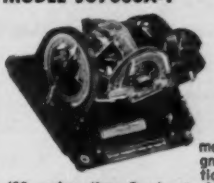
400 CYCLE PM GENERATOR

Mfgd. by T K M Electric Corp.
Model #A-12
120/208 volts, 400 cycle, 1 or 3 phase, 1 kva, pf 0.8, rpm 8,000. Approx. dim. 6" x 5½". Internal spline drive. **Price $100.00**

400 CYCLE 1/3 PHASE GENERATOR

115 VAC. 3 KVA. Mfg. Bogue Elect. Mod. 2800S. External excitation 107 VDC. 1.1 amp. 3450 rpm. 1" shaft. **$200.00**

HONEYWELL VERTICAL GYRO MODEL JG7003A-1



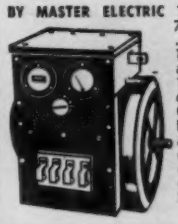
115 volts, 400 cycles, single phase, 35 watts. Pitch and roll potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°.
Weight 5.5 lbs. **Price $35.00 each**

SILICON RECTIFIERS

IN1446	750 amp.	100 volts	.65
IN1447	750 amp.	200 volts	.75
IN1448	750 amp.	300 volts	.85
IN1449	750 amp.	400 volts	1.00
IN05K7	25 amp.	50 volts	2.50
IN1454	25 amp.	100 volts	3.00
IN1455	25 amp.	200 volts	3.50
IN1456	25 amp.	300 volts	4.00
IN1457	25 amp.	400 volts	4.50
IN05M7	35 amp.	50 volts	3.00
IN1458	35 amp.	100 volts	3.50
IN1459	35 amp.	200 volts	4.00
IN1461	35 amp.	400 volts	5.00
IN05P7	50 amp.	50 volts	6.00
IN1462	50 amp.	100 volts	7.00
IN1463	50 amp.	200 volts	8.00
IN1464	50 amp.	300 volts	9.00
IN1465	50 amp.	400 volts	10.00
IN05R7	75 amp.	50 volts	9.00
IN1466	75 amp.	100 volts	10.00
IN1467	75 amp.	200 volts	11.00
IN1468	75 amp.	300 volts	12.50
IN1469	75 amp.	400 volts	14.00
05T7	100 amp.	50 volts	12.50
10T7	100 amp.	100 volts	13.00
20T7	100 amp.	200 volts	14.00
30T7	100 amp.	300 volts	15.00
IN05V7	150 amp.	50 volts	16.50
IN1474	150 amp.	100 volts	17.00
IN1475	150 amp.	200 volts	17.50
IN1476	150 amp.	300 volts	18.00
IN05X7	200 amp.	50 volts	19.00
IN1478	200 amp.	100 volts	19.50
IN1479	200 amp.	200 volts	20.00
IN1480	200 amp.	300 volts	21.00

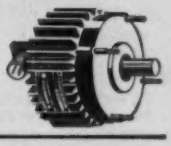
400 CYCLE, 3 PHASE GENERATOR

BY MASTER ELECTRIC



Type AG, frame 364Y, 7.5 kw, 3428 rpm, pf .95 Star connected 120/208 3 phase, 22 amps. Delta connected 120 volt single phase 66 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" long; overall dim. of unit: 21"x18"x 20".
Price **$395.00** each

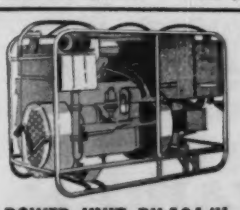
400 CYCLE PM GENERATOR



115/200 volts A.C. 1- or 3-phase, 200 watts. 4,000 r.p.m. Approx. dimensions: 4¾" dia.; 3" long; ½" shaft, AN connector. **$75.00**

400 CYCLE MOTOR GENERATOR

Mfgd. by General Electric
Model #5ATB324E5
Output 120/208 volts AC, 400 cycle, 11.75 kva, 32.6 amp., pf .85. Input 220/440 volts AC, 60 cycle, 3 phase, 15 h.p. Unit complete with motor starter and controls. **Price $750.00**



POWER UNIT PU-104/U

5 KW 120/208 volt AC single or 3-phase permanent magnet type 400 cycle alternator. Alternator is driven by Hercules model ZXB 4-cylinder 4-cycle "L" head liquid cooled gasoline engine. This unit is complete with a control panel.
Price $495.00

CIRCLE 460 ON READER SERVICE CARD

VARIAN
Potentiometer
RECORDERS
Used by the thousands
because . . .

4. ACCESSIBILITY IS

NOTE-ABLE

The Varian G-10's open, horizontal chart is the delight of any man who writes notes. And this recorder is so compact that it can be moved right in close to the work, letting you keep your eyes on the experiment and your pencil on the chart.

Prices from $365; 1% accuracy; 1 or 2½ second full scale balancing time; adjustable or fixed spans 10 to 100 millivolts; wide choice of speeds and accessories. Full specifications and description in Varian literature. Write the Instrument Division.

VARIAN associates
PALO ALTO 1, CALIFORNIA

INDEX TO ADVERTISERS

- Ace Electronics Associates, Inc. 88
- Acme Electric Corporation 34
- Alden Products Co. 80
- American Lava Corporation 93
- Ampex Data Products Co. 43
- Atlee Corporation 81
- Automatic Metal Products Corporation 98
  Avco Corporation Crosley Division ... 76

- Bird Electronic Corporation 48
- Burnell & Co., Inc. 3

  CBS Electronics 75
  California Technical Industries 19
- Cohan-Epner Co., Inc. 97
- Continental Connector Corporation 52
- Cossor (Canada) Limited 102
- Cross Co., H. 95
  Curtiss Universal Joint Co., Inc. 40
- Curtiss-Wright Corporation 92

- Daven Company ..... 3rd Cover
- DeJur-Amsco Corporation 52
- Dialight Corporation 34
  Douglas Aircraft 24-25

- Eitel-McCullough, Inc. 10
  Electronic Capital Corporation 15
- Electronic Measurements Company 7
  Electronic Instrument Company, Inc. (EICO) 100
- Electronics 101

- Fairchild Semiconductor Corporation .. 38

- General Electric Co., Receiving Tubes Div. 50-51
- General Transistor Corporation 23

- Hardwick, Hindle, Inc. 84
  Helland Div., Minneapolis-Honeywell Regulator Co. 30
- Hewlett-Packard Co. 8-9
- Hoffman Electronics Corp. Semiconductor Div. 26-27
  Humphrey, Inc. 20

- Illinois Condenser Co. 101
  Illinois Water Treatment Co. 102
  IBM Research 73
  IT&T Laboratories a Division of International Telephone & Telegraph Corp. 91

  Johnson Company, E. F. 98

- Kurman Electric Co. 97
  Kyoritsu Electrical Instrument Works, Ltd. 97

  Lockheed Missiles and Space Division. 44-45

  Martin Company, The 53
  Missile System Corporation 37
- Mycalex Corporation of America 6

  National Aeronautics and Space Administration 46
- National Semiconductor Corporation .. 2
- Northern Radio Co., Inc. 99

- Pennsylvania Department of Commerce 100
  Penta Laboratories, Inc. 41
- Philco Corporation 54
- Potter Instrument Company 79
  Precision Instrument Company 85

- Radio Corporation of America .. 4th Cover
- Raytheon Co. 12-13, 87
- Rheem Mfg. Company, Semiconductor Division 83
- Ribet Desjardins 16
  Royal Electric Corporation 14

  Shaw Instrument Corporation 21
- Southwestern Industrial Electronics Co. 71
  Sprague Electric Company 5
  Superior Cable Corporation 33
- Sylvania Electric Products, Inc. Semiconductor Div. 47

  Tidewater Virginia Development Council 77
  Transradio, Limited 95

- United Transformer Corporation. 2nd Cover
  Universal Transistor Corporation 101

  Varian Associates 106

- Weston Instruments, Div. of Daystrom, Inc. 31

  York-Hoover Corporation 49

■

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES. 103-104
BUSINESS OPPORTUNITIES 104
EQUIPMENT (Used or Surplus New) For Sale 105

ADVERTISERS INDEX

Bendix Aviation Corp., Bendix Systems Div. 103
Beckman Instruments, Inc. 104
C & H Sales Company 105
Heilveil & Wood 103

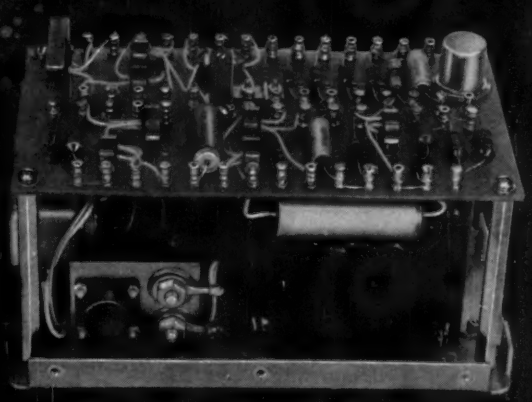
• See advertisement in the June, 1959 Mid-Month ELECTONICS BUYERS GUIDE for complete line of products or services.

This Index and our Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

ULTRA-STABLE

Transistorized Power Supply

62A



AC to DC—regulated ±0.1% for 6 months

Characteristics

Input: 115 V AC 60 cps or 400 cps or
115/208 V AC 3 phase 60 cps or 400 cps

Output: Available in discrete steps of 0.5 volt from
either a. 12.0 volts DC to 28.0 V DC at 1.0 ampere
or b. 28.0 volts DC to 50.0 V DC at 0.5 ampere

Output is floating and can be used either as a positive or negative supply.

Load Regulation: Output voltage is regulated within ±0.1% from 0.5 to 1.0 ampere.

Line Regulation: Output voltage is regulated within ±0.1% for line variations of ±10% in voltage and frequency.

Temperature: Output voltage is regulated within ±0.1%, under full or minimum load, over the temperature range of —55°C to +85°C.

Ripple: Less than 1 milli-volt RMS or 3 milli-volts peak to peak.

Stability: 0.1% for a period of 6 months under a fixed load and line.

Reliability: Better than .95 for a period of 365 days, at 8 hours a day with a life expectancy of 10 years.

Output Impedance: Less than 20 micro-ohms at DC.

This unit can be supplied as a DC to DC Power Supply.

Applications

- Voltage reference in computers and complex networks.
- Laboratory voltage standard.
- Cascaded to provide higher voltages without degradation of performance.

Read about this unit and many other missile and airborne types in the new Daven Catalog of Transistorized Power Supplies!

THE DAVEN CO. LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN ® STANDS FOR DEPENDABILITY

AND NOW THE NEW RCA 50FE5 FOR LOW-COST STEREO

Your answer to low-cost stereophonic or monophonic phonographs with high power-output capability is the new RCA-50FE5—the amazing beam power tube with big-league sound. Only 3 tubes—two RCA-50FE5's and one RCA-12AX7 and you have a complete, compact stereo amplifier.

At B+ voltage of only 145 volts, this 3-tube stereo amplifier can deliver up to 4.3 watts of audio output per channel with cathode bias, and up to 5.6 watts per channel with fixed bias. In a monophonic system with the same low B+ voltage and cathode bias, two RCA-50FE5 tubes in a push-pull circuit can deliver up to 8.5 watts of audio power.

So, if it's high power output at low cost you're after, design your stereophonic and monophonic circuits with the RCA-50FE5. There's a 6-volt heater type (RCA-6FE5) available too! Ask your RCA Field Representative for all the facts. For technical data, write RCA Commercial Engineering, Section A-19-De 5, Harrison, N. J.

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

RADIO CORPORATION OF AMERICA

Electron Tube Division — *Harrison, N. J.*

EAST: 744 Broad Street, Newark 2, New Jersey, HUmboldt 5-3900

MIDWEST: Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill. WH 4-2900

WEST: 6355 E. Washington Blvd., Los Angeles 22, Calif., RAymond 3-8361

3